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Soil Survey

Bartholomew County Indiana

By
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United States Department of Agriculture
with a section on Management of the Soils of Bartholomew County
by
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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
Purdue University Agricultural Experiment Station

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) farmers and others interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) County Surveyed, in which location, extent, physiography, relief, climate, water supply, vegetation, history, and organization, population, industries, transportation, markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Land Uses, in which the major uses of the soils are discussed; (4) Productivity Ratings, in which are presented the productivity of the soils; and (5) Management of the Soils of Bartholomew County, in which the present use and management of the soils are described, their management requirements are discussed, and suggestions made for improvement.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils and Types of Farming in the County the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Land Uses, Productivity Ratings, and Management of the Soils of Bartholomew County.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils and Types of Farming in the County, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on County Surveyed, Agriculture, Land Uses, Productivity Ratings, Management of the Soils of Bartholomew County, and the first part of the section on Soils and Types of Farming in the County of particular value in determining the relations between their special subjects and the soils of the area. Soil scientists and students of soils will find special interest in the section on Morphology and Genesis of Soils.

This publication on the soil survey of Bartholomew County, Ind., is a cooperative contribution from the—

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SOIL SURVEY OF BARTHOLOMEW COUNTY INDIANA

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United States Department of Agriculture in cooperation with the Purdue University Agricultural Experiment Station

CONTENTS

[1] The field work for this survey was done while this Division was a part of the Bureau of Chemistry and Soils.

BARTHOLOMEW COUNTY, located on the flat to undulating plains of south-central Indiana, was settled by families from Ohio, Kentucky, Virginia, and North Carolina soon after the land sales in 1820 and was organized in 1821 with Columbus as the county seat. In the early days forestry was an important source of income, but stock raising, dairying, growing grain crops, and general farming soon came to form the principal features of its economy. The present agriculture consists of two types of farming—grain and livestock, and general farming. Corn, wheat, and hay are the principal crops; special crops and vegetables are becoming important; and the acreage of canning crops is increasing rapidly because of accessible markets and favorable soil conditions. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1936 by the United States Department of Agriculture and Purdue University Agricultural Experiment Station. The report here presented may be summarized as follows.

SUMMARY

The surface features of Bartholomew County consist of a series of glacial till plains and terraces, with a rolling sandstone upland along the border of the western part of the county. The undulating, slightly morainic Wisconsin glacial till plain in the eastern part of the county is separated from the flat stream-dissected Illinoian till plain in the west by the alluvial valley of the East Fork White River with its broad gravel terraces.

The present land use varies widely because of differences in soil character and quality. Originally the entire county was forested with several types of timber. The eastern part, which was originally covered with a beech-maple forest, is now a grain and livestock district. Only a small part is now forested, and the rest is used almost entirely for corn, wheat, and hay. The central part of the county, comprising the gravel benchlands, is adapted to a wheat and livestock system of farming, and there is practically no timber. The greater part of the overflow bottom lands is cropped almost continuously to corn. Only a small part is in forest. The old dune sands bordering

the eastern side of the East Fork White River Valley are well adapted to the culture of melons and other special crops and to general farming, along with dairying, livestock, and poultry raising. Most of the general-farming area of the western part of the county is composed of acid, highly leached soils derived from Illinoian drift. About 25 percent of this land is now cropped, about 40 percent consists of low-grade pasture or idle land, and the rest is in forest. The hill-farming and forestry area consists of the rolling sandstone upland on the western border. This area has a higher proportion of timber and grows less crops than any other part of the county.

Because much of the county is nearly level, the subsoils are heavy, streams have not cut into the broad divides, and extensive areas are naturally imperfectly drained. The well-drained soils comprise about 39.1 percent of the area of the county. They are light in color and low in organic-matter content and range from strongly acid to nearly neutral in reaction. They have pale-brown to brownish-gray surface soils, and the subsoil colors range from light reddish brown in soils with rapid internal drainage to pale yellow in soils with only fair natural drainage. The soils that have exceptionally good internal drainage, owing to loose, unconsolidated sand or gravel substrata, include members of the Fox, Miami, Parke, and Princeton series. The soils with good natural drainage but fairly heavy subsoils include members of the Miami, Russell, Wynn, Cincinnati, Milton, Martinsville, Elkinsville, Zanesville, Wellston, Muskingum, and Rugby series. The soils having only fair natural drainage include members of the Gibson, Haubstadt, Pekin, and Tilsit series.

The imperfectly drained light-colored soils have light brownish-gray surface soils and mottled gray and yellow subsoils at plow depth. They are low in organic matter and require tile drainage for most successful farming. They are intermediate in drainage between the very slowly drained light-colored soils and the naturally well-drained soils. Soil series represented are Ayrshire, Crosby, Fincastle, Avonburg, Whitaker, Homer, Zipp, Dubois, and Bartle. Fincastle silt loam is the most extensive soil in the county, representing 9 percent of the total area.

Very slowly drained light-colored soils, locally known as slash land, have light-gray surface soils and rusty iron spotted and stained subsoils. All have claypans. Clermont, Peoga, and Delmar are the series represented.

The poorly drained dark-colored soils occupy depressions that were swampy or marshy at the time the county was settled. Since they have been artificially drained they are the most productive soils in the county. They are neutral in reaction or nearly so, high in organic matter, and abundantly supplied with plant nutrients and moisture. The Cope, Brookston, Westland, Abington, and Lyles series and a small area of Carlisle muck are included in this group.

The alluvial soils are naturally divided into two large groups, the sweet and the acid bottom soils. They are formed from sediments laid down during each overflow period, and they vary greatly in productivity, depending on the source of the material. The sweet bottom soils, derived from Wisconsin drift, are rich in organic matter and plant nutrients and are highly productive. The well-drained soils include the Genesee and Ross series; the imperfectly drained soils comprise the Eel and Shoals series. The acid bottom soils are formed

largely from Illinoian drift and sandstone sediments. They are quite low in productivity and vary widely in drainage conditions. Pope and Philo represent the well-drained soils, Stendal the imperfectly drained soil, and Atkins the very severely drained soil of the group.

COUNTY SURVEYED

Bartholomew County is in the south-central part of Indiana (fig. 1). Columbus, the county seat, is 40 miles southeast of Indianapolis, 125 miles northeast of Evansville, and 135 miles southwest of Fort Wayne. The total area is 402 square miles, or 257,280 acres.

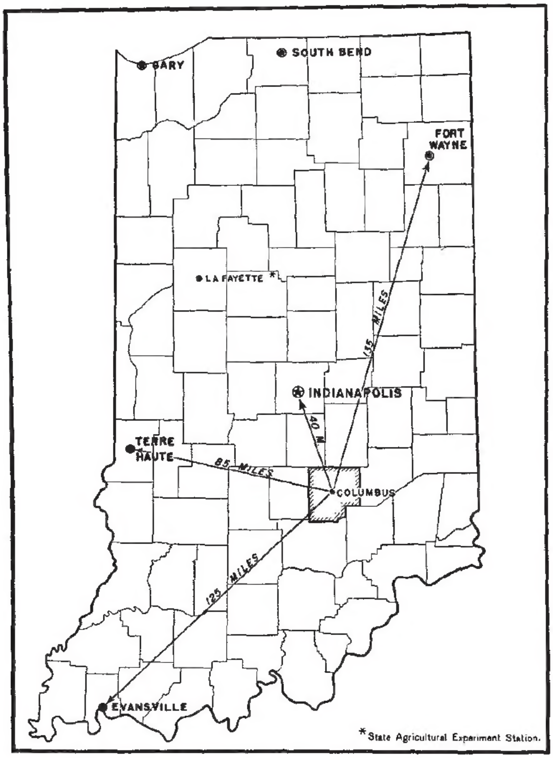

FIGURE 1.—Location of Bartholomew County in Indiana.

The county consists of a series of flat to undulating glaciated plains terminating on the western edge in a rolling upland that rises more than 200 feet above the adjoining plains. Parts of three physiographic regions [2] of the State occur in the county. These are the Norman upland, the Scottsburg lowland, and the Muscatatuck regional slope (fig. 2).

The Norman upland includes the western part of Bartholomew County. It is characterized by rugged hills and narrow steep-sided valleys. It is formed of interbedded sandstones and shales of the

[2] MALOTT, C. A. THE PHYSIOGRAPHY OF INDIANA. Handb. of Ind. Geol., pt. 2, Ind. Dept. Conserv. Pub. 21: 59–256, illus. 1922.

Knobstone formation, and in this county it was not leveled by glacial action. The elevation ranges from 900 to 1,000 feet above sea level, and the valleys are 200 feet or more deep. Along the eastern boundary is a bold escarpment, known as the Knobstone escarpment, where the elevation drops 250 to 350 feet to the level of the Scottsburg lowland.

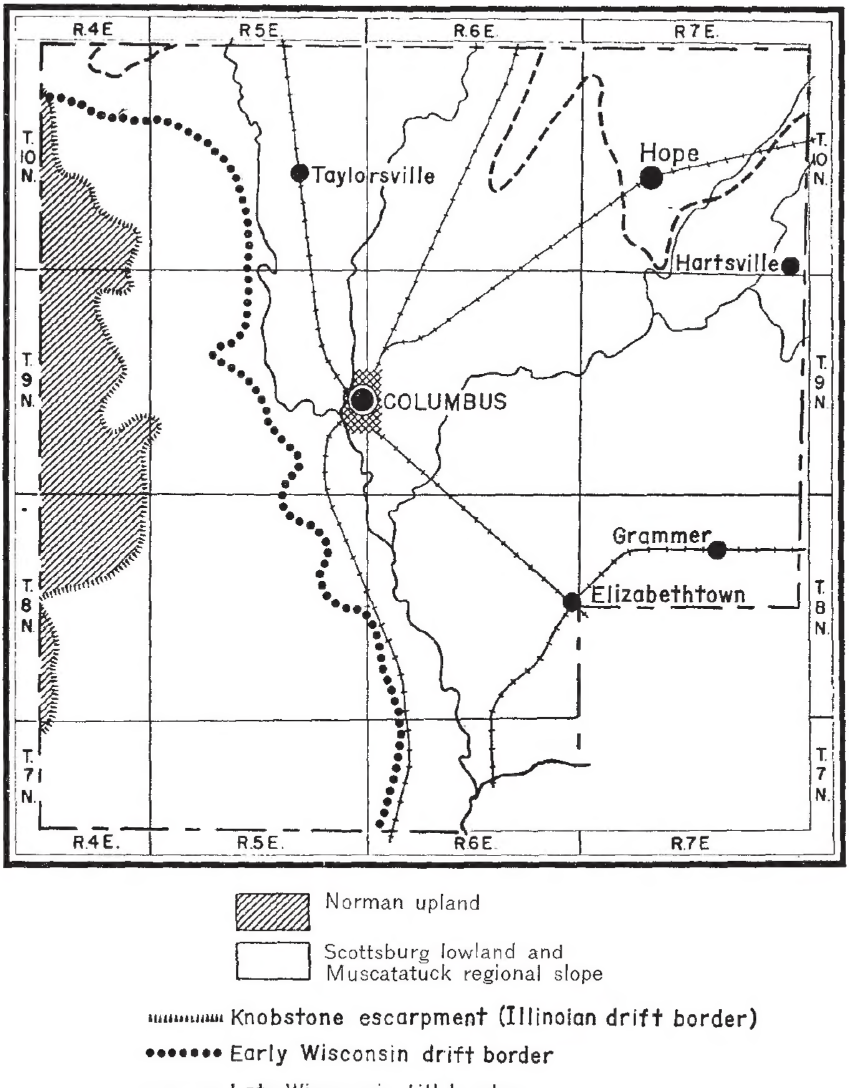

FIGURE 2.—Physiographic and geologic features of Bartholomew County, Ind.

This escarpment is one of the most prominent physiographic features in Indiana. In the southern part of the State there is a drop of 610 feet in about half a mile.

The Scottsburg lowland occupies the central part of the county. It is a low plain extending from the base of the Knobstone escarpment

across the valleys of the Driftwood River, Flatrock Creek, and the East Fork White River. The elevation ranges from about 600 to about 700 feet above sea level. The eastern boundary is obscured by glacial drift. It extends slightly east and south of Flatrock Creek and the East Fork White River, roughly paralleling the line between ranges 6 and 7. Local relief is slight, seldom reaching 75 feet, and the valleys are broad and flat with gently sloping sides.

The upland east of the East Fork White River Valley falls within the physiographic region of the State known as the Muscatatuck regional slope. It is a moderately dissected undulating to smooth plain, rising about 15 feet to the mile in a northeast direction. Winding streams are entrenched for 20 to 50 feet in the glacial till plain and underlying limestone. Valleys of tributary streams are usually less than 10 feet deep, and surface drainage is not good on many of the broad divides such as occur in the southeastern part of the county. The surface configuration of this plain is broken by a belt of glacial morainic knolls 20 to 30 feet high, which extends from south and east of Elizabethtown along the eastern side of the river valley to Columbus and then diagonally northeastward through Hope.

The Scottsburg lowland and the Muscatatuck regional slope were covered by parts of three different advances of glacial ice.

The Illinoian glacial deposits, the oldest in the State, are exposed in the Scottsburg lowland. The main part of this ice sheet did not extend beyond the Knobstone escarpment, but along the margin there is a belt of thin glacial deposits on the sandstone and shale bedrock. The ice sheet pushed across the so-called wall divide in some places, and its drainage waters flowed through the main creeks of Brown County.

West of Lowell Bridge on the Driftwood River is a dissected remnant of an old lake bottom that belongs to the Illinoian glacial period. It has an area of about 2½ square miles. On the eastern edge it rises 50 to 70 feet above the narrow valley of the river and is generally about 10 feet below the level of the Illinoian till plain to the west. In some places it joins the till plain without any change in elevation. The silty and clayey lake deposits overlie glacial till at a depth of 12 to 15 feet.

The Early Wisconsin ice sheet covered the northern and eastern parts of the county and deposited a mantle of drift, ranging in thickness from 10 to 50 feet, on the underlying limestone.

The Late Wisconsin glaciation [3] entered the northern part of the county and deposited isolated tongues of till. In some places a terminal moraine 10 to 20 feet high marks the boundary. This part of the county is slightly more sloping than the eastern part. A few kames or gravel knolls occur near its border with the Early Wisconsin glacial region.

The Broad valleys of the Driftwood and East Fork White Rivers, Flatrock Creek, and tributary streams were formed during the Wisconsin glacial period. Except for a few small streams that flow west into Salt Creek in Brown County, all of the county drains into the East Fork White River.

From Tanneyhill Bridge south to Columbus, the Driftwood River flows in a very narrow valley without extensive terrace development.

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[3] THWAITES, F. T. OUTLINE OF GLACIAL GEOLOGY. Univ. of Wis. 119 pp., illus. 1941.

The east side of the valley is formed by an island ridge approximately 5½ miles long and half a mile wide. During the Early Wisconsin glacial period the Driftwood River probably flowed into Flatrock Creek through a channel in the vicinity of Taylorsville.

Along the eastern border of the East Fork White River Valley and on the upland are scattered areas of old dune sand, the most extensive areas of which are found in the vicinity of Azalia. These sand hills were formed by strong northwest winds sweeping across the valley and carrying the sand along the bluffs, probably during the Late Wisconsin glacial period.

The elevation of the county ranges from 1,003 feet at Mount Healthy to 555 feet where the East Fork White River enters Jackson County. The elevation of Columbus, the county seat, is 628 feet. The average elevation is 685 feet.

Originally Bartholomew County was entirely covered by forest, but much of the area, especially east of the East Fork White River, was quickly cleared to prepare the land for farming. Timber was one of the important sources of income in early pioneer days, but now most of the land has been cleared except for scattered woodland. Nearly all the remaining forest land has been cut over, and about half of it is grazed by livestock. In the Knobstone district, trees are usually cut when they reach tie size. In the rest of the county larger trees are commonly found and the woodland is more productive and receives better care.

The most extensive timbered area is the rolling Knobstone district. Land use studies show that 65 percent of this district is covered by the oak-hickory timber type. The principal species are black, white, and red oak, pignut hickory, and shellbark hickory. On the moist lower slopes some ash, sugar maple, elm, and black gum grow. On the droughty ridge tops and upper slopes chestnut oak and some black and scarlet oak are found. Pin oak and sweetgum are the most common trees on the Illinoian till flats, but a number of other species, including sugar, red, and silver (soft) maple, beech, and black gum or sourgum, also occur.

Beech and maple trees predominate in the Wisconsin glacial district where the soils are moist but not wet. They comprise about 80 percent of the timbered part of this district; but a great variety of other trees, including tuliptree (yellowpoplar), ash, elm, silver maple, red, black, and white oak, and some hickory also grow. On the Haw Patch or gravel benchland, in the vicinity of Columbus, walnut, hackberry, and ash are the dominant species.

Kentucky bluegrass is naturally adapted to the area east of the Driftwood and East Fork White Rivers. West of the rivers, Canada bluegrass, broomsedge, poverty oatgrass, and ticklegrass are better adapted to the acid soil conditions. Common lespedeza is a volunteer legume and is gradually gaining a foothold in this area of acid soils.

The Delaware Indians occupied this section until 1818. The county was surveyed in 1819, and the sale of land began the following year. Jasper Cox, a Virginian, was the first settler. He settled on Haw Creek near Lewis sawmill in 1819. The first white child to be born in the county was John Tipton Lindsey, born in 1819. William Connor, an early Indian trader, came down Flatrock Creek in 1816, but he is reported not to have had a permanent residence.

Most of the early settlers came from Ohio, Kentucky, Virginia, and North Carolina. Within a few years after the county was opened to settlement all the better land had been taken up. The Haw Patch land was occupied first, then the plains extending eastward. It was not until 1833 that the Illinoian till plain and the Knobstone lands were taken up by European immigrants, many of whom came from Prussia.

Bartholomew County was organized January 9, 1821, and originally included a part of Brown County and all of Jackson County. The county was named after Gen. Joseph Bartholomew, an illustrious pioneer. In 1940 its population was 28,276.

Columbus, the county seat, was laid out in 1821 on the site of the small village of Tiptonia. Gen. John Tipton donated 30 acres of land for the town site, and 30 acres was purchased from Luke Bonesteel.

Columbus is a prosperous manufacturing city, having a population of 11,738 according to the 1940 census. Hope is the second largest town in the county, with a population of 1,046. Many small towns are scattered throughout the county, the more important of which are Hartsville, Elizabethtown, Taylorsville, Clifford, Jonesville, Grammer, Walesboro, Garden, Azalia, and St. Louis Crossing.

Bartholomew County is crossed by an excellent system of railways and highways, which connect Indianapolis, Louisville, and Cincinnati. Several bus and truck lines passing through Columbus also serve the county. A fine system of gravel roads connects all parts. Only about 200 miles of dirt roads remain in the county.

Churches and schools are numerous. Except in the western part, all one-room country schools have been consolidated into large graded schools. Telephone connections and electric lines serve most of the towns and many of the farms. In 1940, 861 farms reported having telephones and 1,040 farms had their houses lighted by electricity. An abundant supply of good drinking water is available in all parts of the county. In the river valleys wells are commonly less than 20 feet deep. Water is less plentiful in the Knobstone district, where deep wells are occasionally drilled and cisterns are used to some extent, but most of the water is obtained from shallow wells and intermittent springs. Water-bearing strata are not generally found in this formation.

Manufacturing industries are centered largely in Columbus. The principal products include automobile accessories, radios, multiple pulleys, furniture, hickory handles, Diesel motors, leather, glue, and metal castings. Several large progressive nonagricultural industries give employment to a large number of men.

CLIMATE

Bartholomew County has rather warm, humid summers and moderately cold winters, and the variations in temperatures are wide. During the summer there are occasional periods of hot, sultry weather, which are broken by electrical storms. Rainfall ranges from 40 to 45 inches, with more than is needed in the spring. During July and August there is usually less than the average monthly precipitation, which, combined with high temperature and evaporation, may result in such crops as corn, vegetables, and pasture suffering from drought. The seeding of oats, corn, and truck crops is occasionally delayed in the

spring by excessive rainfall. Because of frozen ground and excess rainfall, field operations cannot usually be carried on for 3 or 4 months during the winter. Wheat is practically the only fall-seeded grain crop, but because of the open winters and midsummer droughts some attempts have been made to grow winter oats. Crops are occasionally damaged by windstorms and hailstorms during the summer.

The average date of the last killing frost is April 27, and of the first, October 16, giving an average frost-free period of 169 days. The latest killing frost recorded in recent years was on May 25, and the earliest was on September 14. Such crops as tomatoes and strawberries are occasionally damaged by late spring frosts. Late corn and tomatoes are sometimes damaged by an early frost.

Table 1, compiled from the records of the United States Weather Bureau station at Columbus, gives the essential data regarding the climate of the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Columbus, Bartholomew County, Ind.*

[Elevation, 632 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1934)	Total for the wettest year (1929)	Average snowfall
	°F.	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	32.6	71	−20	3.22	2.22	4.30	3.7
January	30.4	73	−27	3.69	.78	8.60	5.5
February	31.7	73	−27	2.45	1.60	3.61	4.6
Winter	31.6	73	−27	9.36	4.60	16.51	13.8
March	42.6	89	0	3.97	3.64	4.51	2.3
April	52.5	93	20	3.72	.67	4.47	1.0
May	62.8	98	27	3.49	1.25	9.07	(1)
Spring	52.6	98	0	11.18	5.56	18.05	3.3
June	71.6	103	37	3.63	5.13	4.70	0
July	76.1	111	44	2.87	2.26	4.63	0
August	74.3	105	40	3.72	2.54	1.89	0
Summer	74.0	111	37	10.22	9.93	11.22	0
September	68.2	102	25	3.71	4.35	3.89	0
October	56.0	96	13	3.21	.41	4.26	(1)
November	43.6	78	1	2.78	2.03	3.03	.5
Fall	55.9	102	1	9.70	6.79	11.18	.5
Year	53.5	111	−27	40.46	26.88	56.96	17.6

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

Until the Delaware Indians were moved westward in 1818 there were no white settlers in this section, but after the land sales in 1820 the part of the county east of the East Fork White River was rapidly settled and most of the better lands were soon cultivated. The early development consisted of forestry and farming. The principal crops were corn and wheat, with a small acreage of potatoes as a food crop. The less fertile lands west of the East Fork White River were not settled until about 1833, when European immigrants from Prussia and northern Europe homesteaded this region.

Corn, wheat, and hay have always been the principal crops. Fruits and vegetables are grown on most farms in sufficient quantities for home use. The acreage of the principal crops remained comparatively stable until 1920. Since that time according to the 1940 census, corn has declined about 24 percent and wheat about 47 percent. Potatoes, oats, and commercial orchards have also declined, because the climate and other factors are not well suited to their culture. Crops requiring intensive cultivation or a greater input of labor and management have shown remarkable increases in recent years. This is especially true of tomatoes, sweet corn, melons, dry edible beans, and dairy and poultry products. Soybeans and alfalfa have greatly increased in importance. Table 2 gives the acreages of the most important crops in stated years.

TABLE 2.—*Acreages of the principal crops in Bartholomew County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn for grain	57, 170	50, 992	53, 623	58, 093	56, 814	45, 853	43, 368
Wheat	38, 448	48, 313	56, 899	46, 635	56. 625	37, 516	30. 210
Oats, threshed	5, 925	8, 662	5, 146	4, 734	7, 668	5, 503	1, 599
Oats, cut and fed unthreshed						1, 192	665
Rye	155	270	106	64	1, 448	1, 051	1, 126
Soybeans						2, 664	10, 413
Vegetables for sale					968	5, 407	9, 847
Potatoes		910	769	638	639	323	205
Sweetpotatoes	46	44	49		24	8	11
Hay	10, 046	22, 637	28, 234	24, 853	22, 022	23, 775	17, 489
Timothy, and timothy and clover mixed				15, 253	15, 898	13, 434	7, 375
Clover			12, 173	8, 805	5, 073	6. 449	234
Alfalfa				112	256	1, 095	2, 716
Legumes for hay					84	2, 143	6, 219
Other hay			16, 061	683	711	654	945
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		57, 816	105, 013	65, 162	40, 142	27, 950	10, 930
Peaches		9, 633	40, 410	21, 331	11, 579	19, 854	2, 934

In 1940 there were 1,815 farms in the county. According to the 1940 census, 226,068 acres of land, or 87.9 percent of the area of the county, was included in farms, of which the acreage was classified as follows: 111,946 acres in crops, 32,736 acres in plowable pasture, 25,895 acres in woodland, 2,610 acres involved in crop failure, 19,034 acres in idle cropland, and 33,847 acres constituting all other land in farms.

The most extensive areas of woodland, idle cropland, and pasture land occur in the western part of the county. Most of this pasture land grows grasses of low nutritive value, and the carrying capacity would probably be less than 1 animal unit to 5 acres of pasture. However, insufficient livestock is kept in the western part to pasture more than a small proportion of the land classed as pasture land.

The growing of vegetables and special crops is assuming a very important place in the agriculture of the county. Tomatoes and sweet corn are the dominant crops, representing about 95 percent of the vegetable acreage. In 1939, 9,847 acres of vegetables were grown for sale. In 1929, 5,407 acres were grown; but in 1919 these crops represented less than 1,000 acres. The acreage of canning crops has been increasing rapidly because of accessible markets and favorable soil conditions. Canneries are located at Columbus, Edinburg, and Seymour. In 1939 the value of all vegetable crops raised for sale, as reported by the census,

was $232,356. The value of certain agricultural products, as reported by the Federal census for stated years, is shown in table 3.

TABLE 3.—*Value of certain agricultural products in Bartholomew County, Ind., in stated years*

Product	1909	1919	1929	1939
Crops produced:				
Cereals	$1,932,096	$4,713,917	$1,727,962	$1,289,200
Other grains and seeds	42,348	41,578	34,009	64,213
Hay and forage	248,898	844,602	284,580	230,863
Tobacco	(1)	(1)	40,594	53,492
All vegetables	97,244	170,637	302,877	286,174
Vegetables (except potatoes and sweetpotatoes) for home use and for sale			262,355	269,341
Potatoes and sweetpotatoes			40,522	16,833
Fruits	22,755	39,219	72,648	27,747
All other crops	88,187	10,048	1,802	2,815
Nursery, greenhouse, and hothouse products sold	(2)	(2)	43,236	3,971
Forest products sold	(2)	(2)	32,637	6,685
Livestock products:				
Cattle, swine, and sheep sold and slaughtered	1,005,767	(2)	(2)	850,934
Dairy products sold	87,078	331,449	461,314	286,312
Poultry and eggs produced	349,145	472,333	539,991	281,364

[1] Included in the value of "All other crops." [2] Not reported.

Commercial fertilizers are used generally throughout the county. In 1920 about 69 percent of the farmers reported using $152,365 worth of fertilizers, an average of about $108 to the farm reporting. There was a steady increase in the use of fertilizer prior to 1921. In 1939 about 65 percent of the farmers used fertilizer valued at $79.39 per farm. The use of barnyard manure supplemented by commercial fertilizer is a common practice where dairying and livestock systems of farming are followed. Fertilizers are nearly all purchased ready-mixed. The value of lime to correct soil acidity is generally recognized, especially when clover failure occurs. Ground limestone is the most common form of lime used.

It is the general practice for most of the farmers to fertilize wheat and special crops with 100 to 150 pounds of 2–12–6 [4] fertilizer to the acre. For tomatoes and tobacco 300 to 500 pounds of 4–12–8 or 3–8–12 fertilizer is used. Corn is fertilized to a limited extent.

Many farmers throughout the eastern part of the county require extra labor during the summer months, especially for harvesting special crops and corn. Usually sufficient laborers are available at reasonable rates. On the larger farms labor is hired on a monthly or an annual basis, the laborers being paid a monthly wage plus a house and various incidental subsistence items. The total expenditure for labor in 1939 was $220,750, an average of about $296 for the 41.1 percent of the 746 farms reporting.

In 1940, according to the Federal census, the average size of farms was 124.6 acres. The farms range from less than 3 to over 1,000 acres. About 7 percent are less than 10 acres in size. Many of these farms are located in the vicinity of Columbus, where the operators have part-time employment in the city. The model size of farm group ranges from 70 to 99 acres and comprises 16 percent of the number of farms. About 44 percent of the farms range from 70 to 179 acres. Only about 3 percent of the farms range from 380 to 1,000 acres.

[4] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

According to the 1940 census, 70.6 percent of the farms were operated by owners, 28.9 percent by tenants, and 0.5 percent by managers. The share system of rental is used almost to the exclusion of cash rental. The usual rental is for the landlord to receive one-half of such crops as corn, wheat, soybeans, and hay and receipts for livestock products and to pay for one-half of the fertilizer and seed. He also furnishes the lime and keeps the buildings and fences repaired. For crops such as tomatoes and melons, which require more labor, the landlord's share ranges from one-third to two-fifths.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of layers or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, content of organic matter, roots, gravel, and stone are noted. The reaction of the soil and its content of lime and salts are determined by simple tests.[5] The drainage, both internal and external, and other external features, such as relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the three principal of which are (1) series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas of land—such as riverwash and rough stony land—that have no true soil are called (5) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage conditions, and other important internal characteristics, and the same range in relief. The texture of the soil profile, especially to plow depth, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Fox, Russell, and Fincastle are names of important soil series in Bartholomew County.

[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Indicator solutions are used to determine the reaction of the soil. The presence of lime in the soil is detected by the use of a dilute solution of hydrochloric acid.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture, such as sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Fox loam, Fox silt loam, Fox sandy loam, and Fox gravelly loam are soil types within the Fox series. Except for texture these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the type in some feature, that may be of special practical significance. Difference in relief, stoniness, and degree of accelerated erosion may be shown as phases. For example, within the normal range of relief for a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though no important differences may be apparent in the soil profile or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, some soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

Aerial photographs are used as a base for mapping soils in Indiana. The pictures are taken from an airplane flying at a height of about 13,500 feet, and each picture covers about 4½ square miles. About 250 pictures were taken to cover Bartholomew County. A map showing roads, buildings, streams, soils, and other features was drawn on a sheet of celluloid covering the picture, to separate the map and the photographic features. All features mapped were identified and located on the picture by going over the ground closely enough, either by automobile or on foot, to see at least two sides of every 40-acre field. Soils were studied and identified by observing road cuts and by boring with a soil auger. Soil boundaries and other features were then drawn in their correct positions and in their proper relations to all other features. The field maps were later assembled into larger sheets, from which the final colored map was produced.

SOILS AND TYPES OF FARMING IN THE COUNTY

The many soils in Bartholomew County range from silty clay loam to fine sandy loam, from high to low in organic-matter content, from very strongly acid to neutral in reaction, and from very low to very high in productivity. About 71 percent of the soils may be classed as silt loams, 12 percent as silty clay loams, and 17 percent as moderately sandy loams and sandy loams. Good tilth can be maintained easily on all the sandy soils and also on the silt loams where tillage operations

are performed at the proper moisture content. About 43 percent of the soils originally were poorly drained. For best results these soils require artificial drainage by tiling or ditching. Much of the land in the eastern and northern part of the county has been tile-drained. In this area good farming methods must provide for building up the organic-matter content of the soil to maintain fertility and granular

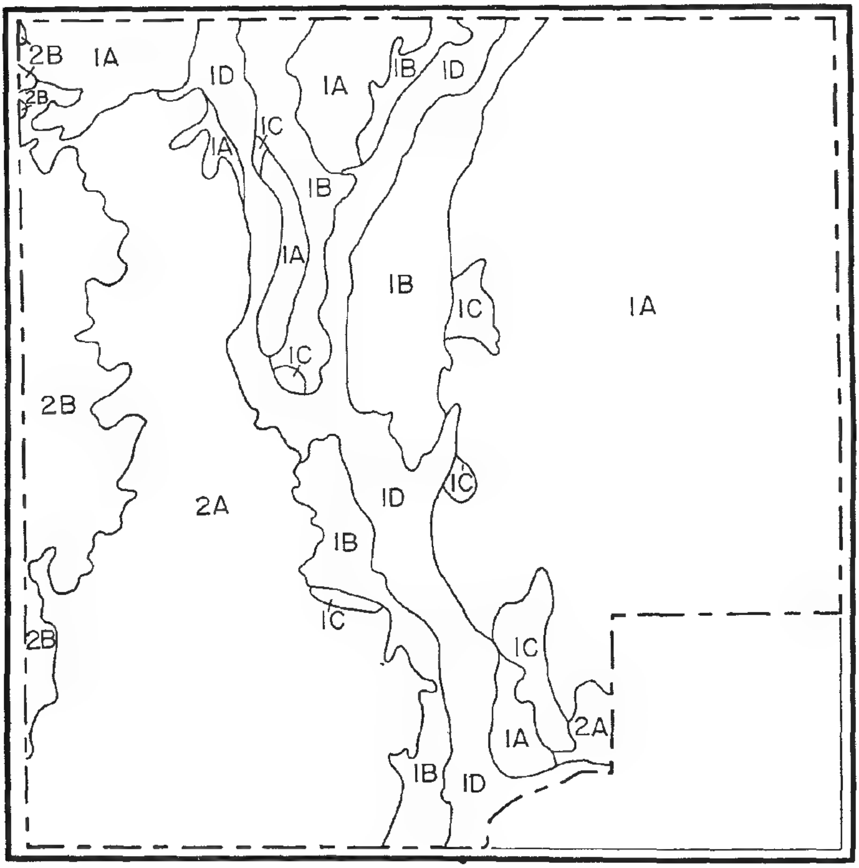

FIGURE 3.—Subdivisions of Bartholomew County, Ind., according to types of farming (grain and livestock, district 1; general farming, district 2); 1A, Corn, wheat, and livestock area; 1B, wheat and livestock area; 1C, area of special crops and general farming; 1D, cash-grain area; 2A, general-farming area; and 2B, hill-farming and forestry area.

structure. About 32 percent of the soils are strongly acid, 45 percent are medium acid, and 23 percent are slightly acid or neutral in reaction.

Because of the effect of parent material and topography on soil character and agricultural productivity, the county may be divided into two main agricultural districts, the farming systems of which may be designated as follows: District 1, grain and livestock; district 2, general farming. The type of farming practiced is very closely related to marked differences in the soil. With the exception of the western rolling land, the soils of both districts are nearly level and

the proportion of the soils requiring artificial drainage is about the same. The west side of the valleys of the East Fork White and Driftwood Rivers and Nineveh Creek is the boundary line between the two districts, with grain and livestock farming to the east and general farming to the west.

These two main agricultural districts of the county subdivide naturally into agricultural areas as shown roughly in figure 3.

In the following pages the soils of Bartholomew County are described in detail and their agricultural relations are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Bartholomew County, Ind.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Russell silt loam	13,056	5.1	Genesee loam, high-bottom phase	256	0.1
Russell silt loam, shallow phase	6,528	2.5	Genesee fine sandy loam	384	0.2
Wynn silt loam	192	.1	Genesee silty clay loam	1,344	.5
Russell loam	768	.3	Ross silty clay loam	3,200	1.3
Russell silt loam, eroded phase	192	.1	Ross loam	128	(1)
Russell silt loam, steep phase	1,536	.6	Eel silty clay loam	7,488	2.9
Miami silt loam	4,224	1.6	Eel silt loam	8,320	3.2
Miami silt loam, eroded phase	128	(1)	Eel loam	704	.3
Miami silt loam, slope phase	128	(1)	Shoals silty clay loam	832	.3
Martinsville silt loam	1,856	.7	Riverwash	64	(1)
Martinsville loam	5,120	2.0	Gibson silt loam	11,712	4.6
Milton silt loam	960	.4	Gibson silt loam, slope phase	8,064	3.1
Rugby silty clay loam	256	.1	Haubstadt silt loam	576	.2
Fincastle silt loam	23,872	9.3	Haubstadt silt loam, slope phase	576	.2
Fincastle silt loam, shallow phase	6,720	2.6	Pekin silt loam	3,008	1.2
Fincastle loam	320	.1	Cincinnati silt loam	3,072	1.2
Crosby silt loam	6,208	2.4	Cincinnati silt loam, shallow phase	1,088	.4
Delmar silt loam	512	.2	Cincinnati silt loam, eroded phase	832	.3
Whitaker silt loam	2,752	1.1	Cincinnati silt loam, gullied phase	1,344	.5
Whitaker loam	2,560	1.0	Cincinnati silt loam, steep phase	5,952	2.3
Homer loam	1,600	.6	Parke silt loam	128	(1)
Zipp silty clay loam	64	(1)	Elkinsville silt loam	320	.1
Brookston silty clay loam	3,648	1.4	Avonburg silt loam	7,552	2.9
Cope silty clay loam	12,224	4.8	Dubois silt loam	192	.1
Westland silty clay loam	3,520	1.4	Bartle silt loam	3,520	1.4
Westland loam	448	.2	Clermont silt loam	7,744	3.0
Abington silty clay loam	320	.1	Peoga silt loam	1,536	.6
Lyles silty clay loam	384	.2	Zanesville silt loam	4,032	1.6
Lyles loam	512	.2	Zanesville-Wellston silt loams, eroded phases	128	(1)
Carlisle muck	64	(1)	Zanesville-Wellston silt loams, gullied phases	960	.4
Fox loam	14,400	5.6	Wellston silt loam	384	.2
Fox gravelly loam	512	.2	Wellston silt loam, slope phase	1,024	.4
Fox silt loam	1,408	.6	Tilsit silt loam	128	(1)
Fox sandy loam	1,024	.4	Muskingum stony silt loam	7,040	2.7
Nineveh loam	3,136	1.2	Muskingum gravelly silt loam, colluvial phase	128	(1)
Nineveh gravelly loam	576	.2	Pope gravelly loam	320	.1
Martinsville fine sandy loam	2,240	.9	Pope silt loam	1,664	.7
Princeton fine sandy loam	3,200	1.3	Philo silt loam	4,288	1.7
Princeton fine sandy loam, slope phase	256	.1	Stendal silt loam	10,688	4.2
Princeton loamy fine sand	128	(1)	Atkins silt loam	3,328	1.3
Ayrshire loam	1,280	.5	Pits and quarries	192	.1
Genesee silt loam	10,176	4.0			
Genesee silt loam, high-bottom phase	512	.2			
Genesee loam	3,520	1.4	Total	257,280	100.0

[1] Less than 0.1 percent.

SOILS AND CROPS OF THE GRAIN AND LIVESTOCK DISTRICT

From a geological viewpoint and also according to stage of soil development, the soils in the grain and livestock district (district 1) are younger than those in the general farming district (district 2).

In district 1, as in the Wisconsin glacial region, water has dissolved the carbonates of lime and magnesium and the more easily removed plant nutrients to a depth of 2½ to 5 feet. The soils of district 2 are very much more highly leached and more strongly acid in reaction, contain less available plant nutrients, and as a group have a lower content of organic matter than the soils of district 1. In the Illinoian glacial region, which comprises most of district 2, the carbonates have been removed to an average depth of about 10 feet.

CORN, WHEAT, AND LIVESTOCK AREA

The corn, wheat, and livestock area (1A) is the most important agricultural subdivision of the county in area and in diversity and value of crops. The most important soil series are the Russell, Miami, Fincastle, Crosby, Brookston, and Cope. A systematic rotation of corn, wheat, and clover is followed. The corn and roughage or hay crops are fed to hogs and beef or dairy cattle. Wheat is raised as a cash-grain crop, and on many farms a small acreage is used for growing tomatoes. Most of the land is level to gently undulating. About 80 percent of the total area of soils of this area requires artificial drainage; about 20 percent are naturally well-drained, 20 percent are poorly drained, and 60 percent are imperfectly drained. As the soils are only moderately acid, little difficulty is experienced in growing legumes, especially when lime has been applied to the more acid soils. Hay, corn, and soybeans produce adequate supplies of feed for the livestock. Corn and soybeans need the greatest quantity of moisture during the period when rainfall is lowest and evaporation is highest. Consequently the Brookston and Cope soils and the overflow soils of the bottoms—Eel and Genesee—are best adapted to these crops. Corn is best adapted to soils having an abundant supply of nitrogen, organic matter, phosphorus, potash, and moisture.

Wheat and oats require a great deal of moisture in the spring. When wheat is seeded on poorly drained soils, such as Brookston, it may suffer from winterkilling and is likely to lodge just before harvest.

Oats are not well adapted to the climate of the southern part of the State. The weather is usually too warm and the moisture supply is not plentiful at the time when the grain is maturing. When oats are grown, however, they are seeded early to insure maturity before the midsummer drought. Most farmers raise only a few acres of oats for feed. Oats are best adapted to rich soils, such as the Brookston and Cope, but the income per acre makes it more profitable to raise corn on such soils.

Except in the overflow bottom area, many farms have a small acreage of soybeans. This crop is grown for both hay and seed. Because of their drought-resisting qualities, soybeans are suited to soils that have low water-holding capacity, such as those of the gravel plains in area 1B. Because of their ability to grow on strongly acid soils, soybeans are also raised as a leguminous hay crop west of the East Fork White River Valley.

Alfalfa and sweetclover are best adapted to well-drained soils that are slightly acid to neutral in reaction. They are grown most extensively on the gravelly benchland of the Haw Patch. Small fields are found on many farms throughout the eastern and northern part of the county.

Red clover is grown most extensively in the grain and livestock district. It is best adapted to soils that are neutral to moderately acid in reaction and does not resist drought well enough to be widely grown on the Haw Patch lands.

Vegetable canneries at Columbus and Edinburg furnish a market for truck crops. Tomatoes, sweet corn, and pumpkins are the principal crops grown for the canning industry. These crops are well-adapted and widely grown throughout the eastern part of the county and to a more limited extent in the western part. Crops are usually raised under contract for local canneries, but some growers sell their crops in Indianapolis.

Tomatoes are usually planted after the land has been used for meadow or for corn. They are fertilized with 200 to 400 pounds of 2–12–6 mixture to the acre. Manure is applied to the land on many farms. Tomatoes are planted after danger of frost has passed. The harvest period extends from July until frost in late October. Yields range from 8 to 12 tons an acre on the better soils and 5 to 8 tons on less productive soils. When sweet corn is grown it replaces field corn in the system of farming. It is most extensively grown in the overflow river bottom soils. Occasionally late plantings are made, which mature about the time of frost. Yields range from 2 to 5 tons an acre. Corn for hominy is grown extensively in the vicinity of Taylorsville. Most of it is reported to be sold at a premium over yellow corn raised for grain. Cabbage is grown to some extent on the dark-colored soils and the overflow bottoms. Yields range from 13 to 20 tons. The crop is usually transported by truck to the Indianapolis market.

WELL-DRAINED SOILS

The naturally well-drained soils of the corn, wheat, and livestock area (1A) comprise about 28 percent of the area of the district and 11 percent of the county. They are light-colored, low in organic-matter content, and medium acid in reaction, and they can retain a good supply of moisture for plant growth. These soils occur on moderately sloping land, which subjects them to considerable sheet erosion when cultivated. The more sloping areas occur along streams. The soils in this group are Russell silt loam; Russell silt loam, shallow phase; Wynn silt loam; Russell loam; Russell silt loam, eroded phase; Russell silt loam, steep phase; Miami silt loam; Miami silt loam, eroded phase; Miami silt loam, slope phase; Martinsville silt loam; Martinsville loam; Milton silt loam; and Rugby silty clay loam.

Russell silt loam.—This soil type, occupying a total area of 13,056 acres, is the most extensive soil in this well-drained group. It occurs on morainic knolls and on the moderately sloping land along the streams of the Early Wisconsin glacial region. The small knolls rise from a few feet to 30 feet or more above the surrounding level imperfectly drained soils with which they are associated.

Originally this soil was covered by a forest of hardwood timber consisting of black walnut, sugar maple, black and white oaks, American elm, and ash. It is estimated that 95 percent of the land has been cleared and put under cultivation.

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The 9- to 12-inch surface layer is light grayish-brown to grayish-yellow smooth silt loam under air-dry field conditions. After rains the soil has a light-brown color. The reaction is medium acid. Under a forest cover the 3-inch surface layer is dark brownish gray, owing to the penetration of the decomposing organic matter. When the soil is cultivated it rapidly loses much of this organic matter.

The subsoil, at a depth of 9 to 12 inches, is a moderately friable silty clay loam, which crumbles readily into subangular particles three-eighths to three-fourths of an inch in diameter. It becomes more compact and heavier with depth. The color grades from brownish yellow in the upper part to yellowish brown or light brown in the lower part, with some gray mottling occasionally appearing below a depth of 24 to 30 inches in the compact rather impervious subsoil, indicating that in such areas the internal drainage is somewhat slow. The subsoil is strongly acid to a depth of 36 inches. At an average depth of 46 inches the limy grayish-yellow glacial till is found. This material consists of a mixture of clay, silt, fine sand, and glacial pebbles deposited during the Early Wisconsin glacial period.

In most places a few glacial pebbles are found throughout the soil profile. In a few areas the upper 20 inches of the soil profile consist of very smooth silty soil material, probably brought in by northwesterly winds from the adjoining stream bottoms during recent geologic times. Areas of this variation of Russell silt loam occur in a long narrow belt east of Edinburg.

Adjoining the valleys of the streams in the eastern part of the county, limestone often occurs at shallow depths. This underlying limestone has changed the Russell silt loam to some extent, improving the underground drainage, and in some places producing the sinkhole surface configuration characteristic of some soils of limestone areas. The largest area in which this condition prevails is in the vicinity of Burnsville. Some of the Russell silt loam in this vicinty has the flat topography characteristic of the imperfectly drained soils, but natural drainage and profile characteristics are like those of the typical Russell silt loam. Bedrock usually occurs at depths of 5 to 8 feet.

Good internal drainage and aeration of the soil are shown by the yellowish-brown to brown subsoil. Surface drainage ranges from good to excessive, depending on the slope of the land. The gradient of the slope ranges from 4 to 12 feet per 100 feet, or 4 to 12 percent. On the steeper slopes erosion is a serious problem.

Depletion of the organic matter of the surface soil results in the soil's baking and losing much of its original mellow physical condition. The content of organic matter in the surface soil is much lower than that of the dark-colored poorly drained Cope and Brookston soils, but it is also somewhat higher than in most of the light-colored soils of the county. As livestock is kept on most farms, manure and crop residues are returned to the soil to aid in maintaining the content of organic matter. Since sheet erosion is active on unprotected sloping areas, the physical condition may also be impaired by loss of the surface soil and by plowing up the heavy subsoil. The surface soil is medium acid in reaction. Most farmers find that applications of 1 to 2 tons of ground limestone to the acre are necessary to assure a good stand of red clover.

The usual crop rotation consists of corn, wheat, and meadow of red clover or mixed hay for 1 year each, and occasionally 2 years of

meadow. Corn is the dominant crop and occupies 25 percent of the soil type. It is usually planted in fields that were in meadow the preceding year. Plowing is generally done in the spring, as destructive erosion will result from fall plowing on sloping land. Corn is usually planted between May 10 and 15. Yields range from 35 to 45 bushels an acre under average conditions of management. The yields are not so high on the well-drained soils as on the associated dark-colored soils, which are naturally poorly drained, because supplies of organic matter and moisture are much lower in the former soils. The gradual loss of surface soil by erosion under this system of farming has gradually reduced yields over a period of years. Corn requires more moisture during a period when rainfall is low and evaporation is high; whereas wheat requires the most moisture in the spring and early summer, when the supply is abundant. Consequently, wheat and hay suffer less from moisture deficiency and are better adapted to the more sloping areas. Wheat is grown on about 21 percent of Russell silt loam. Wheat is usually seeded in the standing corn, although farmers generally recognize that yields are lowered slightly by this practice. Yields usually average about 20 bushels an acre. Practically all farmers fertilize their wheat with 125 to 150 pounds or more of 2–12–6 or 2–12–12 fertilizer. Some farmers use fertilizer on cornland. Available manure is applied first on wheatland, and the rest is put on the cornland. As Russell silt loam is medium acid, considerable trouble has been experienced in obtaining good stands of red clover. Medium red and mammoth red clover are grown successfully where the soil has been limed. Yields average about 1 to 1½ tons an acre. Because of acid soil conditions, mixed hay, consisting of red and alsike clover, redtop, and timothy, is widely seeded. Alfalfa and white sweetclover are grown to some extent. An application of 2 tons of lime to the acre is needed to obtain a good stand.

A larger part of Russell silt loam than of poorly drained soils is used for pasture. This condition is due to the susceptibility of the soil to sheet erosion and the necessity of keeping a good ground cover on the more sloping areas. Erosion has reduced the thickness of the surface soil and consequently the crop yields, particularly of corn. Many fields are kept in hay several years, after which they are used as pastures.

Russell silt loam, shallow phase.—This phase occurs between Hartsville, Newbern, Hope, and Rugby. Like the normal phase, it has an undulating to sloping relief and occurs principally along streams and on morainic knolls. A total of 6,528 acres was mapped.

This phase has a smooth mellow surface soil that is light brown when wet and light grayish brown when dry. It has a fine-crumb structure and is easily kept in a mellow condition. The 9- to 12-inch surface soil is low in organic matter and slightly less acid than Russell silt loam.

The subsoil, at a depth of 9 to 12 inches, is a yellowish-brown or light-brown silty clay loam, which crumbles readily into subangular particles from one-fourth to one-half of an inch in diameter. Roots of plants penetrate the subsoil easily. The lower subsoil layer is slightly heavier and more compact and breaks into larger structure particles. The subsoil is medium to slightly acid. Calcareous friable grayish-yellow pebbly clay loam occurs at an average depth of 34

inches. This parent material consists of a heterogeneous mixture of silt, clay, sand, and gravel deposited during the retreat of the Wisconsin glacier.

In a few places along the streams where limestone is close to the surface of the ground, Russell silt loam, shallow phase, may be underlain by rock at a depth of 5 or 6 feet. The character of the soil is not changed, but the topography is less sloping.

The soil of the shallow phase is less acid than the normal soil, therefore red clover is grown more easily, although many areas require lime in order to obtain satisfactory stands. Liming is necessary for growing sweetclover and alfalfa. A 3-year rotation of corn, wheat, and red clover or mixed hay is generally followed. Soybeans are grown to some extent. Corn yields average about 40 bushels an acre. Wheat, which is generally fertilized, averages about 20 bushels an acre.

Wynn silt loam.—A total of 192 acres of this soil was mapped. The largest areas occur at Burnsville and south of Hartsville. The soil resembles Russell silt loam except that the glacial till is shallow and lies over limestone. The lime has been leached from the till. The 10-inch surface soil is a light mellow grayish-brown silt loam, underlain by friable yellowish-brown to light-brown slightly gritty silty clay loam, which breaks into subangular particles one-fourth to three-fourths of an inch in diameter. This soil rests on limestone at depths of 40 to 60 inches. The 10-inch subsoil layer has been modified by the limestone and is a moderately tough heavy brown clay loam.

Russell loam.—The 9- to 15-inch surface layer of Russell loam is light grayish-brown or yellowish-brown loam. It includes a loose mellow fine sandy loam and friable loam that contains just enough sand to make it work easily. The surface soil is low in organic matter and moderately acid. Owing to the heavy clayey subsoil, a good supply of moisture is generally available for crops. The subsoil layer, at a depth of 12 to 20 inches, ranges from a yellowish-brown loam to a heavy silty clay loam, but is mostly a moderately heavy clay loam. The lower subsoil layer is a light-brown friable silty clay loam, slightly acid in reaction, which is underlain by calcareous mixed sand, gravel, and clay.

Included with Russell loam in mapping are a few high knolls in section 23, 2 miles northeast of Clifford, which have gravelly substrata. The surface soil is light-brown loam, 10 to 12 inches thick; but owing to the rolling relief, erosion is active, resulting in the loss of much of the surface soil and occasional exposure of subsoil. The subsoil is brown friable gravelly clay loam that becomes quite hard when dry. At a depth of 3 to 5 feet it is underlain by loose gray calcareous gravel. The soil has relatively low moisture-holding capacity and is susceptible to erosion; therefore it is more droughty and less fertile than Russell loam. If the area were larger this included soil would be mapped as Bellefontaine loam.

Russell loam occupies a total area of 768 acres. It occurs in small areas along the river bluffs, principally southeast of Columbus from State Highway No. 7 to Sand Creek. The largest area occurs 1 mile east of Azalia. This soil consists of a thin veneer of sandy material overlying a silty clay loam subsoil. It is gently undulating and occurs

on the east side of and adjacent to the dune sands. The mixed character of the soil is due to the variable deposition of sand on the clay.

Corn, wheat or rye, soybeans, and mixed hay are the principal crops grown. Red clover is less important, as it is more susceptible to drought injury. Some crops such as watermelons and cantaloups are adapted to the more sandy areas. Corn yields 30 to 35 bushels an acre, and wheat about 14 bushels. Erosion is not a very serious problem.

Russell silt loam, eroded phase.—This phase differs from the normal Russell silt loam principally in the thickness and texture of the surface soil. The light grayish-brown surface soil is from 2 to 7 inches thick and is rarely more than plow depth. In most places the color has been changed to light brown, owing to mixture with the subsoil in plowing. The texture ranges from a silt loam to a light silty clay loam. The content of organic matter is lower than that of the normal Russell silt loam, because much of the richer surface soil has been lost and some of the subsoil, which is very low in organic matter, is mixed with the plow soil. An occasional gully cuts into and exposes the light-brown silty clay loam subsoil. The glacial till consists of calcareous somewhat pebbly clay loam.

A few areas that have been severely sheet-eroded and are badly dissected by gullies are included. Such areas are used for pasture or are waste land, unsuited to agriculture.

The total area of Russell silt loam, eroded phase, is 192 acres. Its agricultural value depends on the quantity of surface soil remaining.

This phase occurs on slopes of 5 to 15 percent. Under cultivation these slopes have been denuded of their surface soil through failure to use methods that would protect them from rapid runoff. During each rain the water removes a thin layer of surface soil, until the ploy soil finally includes a part of the subsoil. The plow soil gradually becomes more plastic and less permeable to moisture and loses its mellow physical condition, and erosion is further hastened by the reduced ability of the surface soil to absorb water. Tillage operations are usually performed up and down the slope to encourage rapid runoff. Sheet erosion appears to be more severe on Russell silt loam than on the other rolling members of this group. Yields of crops are gradually lowered until this eroded phase is unsuited for general farm crops and reverts to meadow or pasture. The heavy acid subsoil with its low content of available plant nutrients is not well suited for growing clover and other desirable hay or pasture plants.

Wheat is grown on approximately two-thirds of this soil, and the rest is used largely for hay and pasture. When corn is grown the yield is low and erosion is accelerated. Mixed hay is more widely grown than red clover.

Farmers are generally becoming more conscious of the damage done by erosion and are changing their methods of managing the sloping lands. The most frequent changes that are being made on these soils are to use them for meadows or pastures, which hold the soil in place and prevent the water from running off rapidly.

As the well-drained surface soils of this area are only medium acid, they may be seeded to alfalfa if lime is applied and the seed is inoculated to encourage nodule formation on the roots. Alfalfa is not well adapted to severely eroded areas that have lost all the surface soil. Lespedeza and black locust are commonly used in re-

claiming areas that are no longer suited to agriculture. Contour farming and strip cropping prevent rapid runoff and reduce erosion.

Russell silt loam, steep phase.—This phase occupies a total area of 1,536 acres. Its slopes range from 15 to 30 percent, which should preclude its general use for cultivation. This phase occurs in narrow strips along the streams in the eastern part of the county and is best used for pasture and woodland. About 72 percent of it has been cleared of timber, and 42 percent of this is now cropped; approximately 20 percent consists of good-grade bluegrass pasture, and the rest is idle land or low-grade pasture. Owing to the steepness of the slopes, the soil erodes readily when clean-tilled crops are grown.

This soil is similar to Russell silt loam in most respects. The texture of the surface soil ranges from silt loam to loam. Along the east side of the East Fork White River there is a tendency for the surface soil to be loamy because of the drifting of sand from the valleys.

Along Clifty Creek between Newbern and Hartsville a few areas of this steep phase are mapped with Russell silt loam, shallow phase. At a depth of 3 feet these areas have limy parent material in the subsoil, instead of at 4 to 6 feet as in the normal soil. Along the streams in the eastern part of the county limestone occurs at depths of 4 to 7 feet under some of this soil.

Miami silt loam.—This soil occurs on morainic knolls and sloping land along valleys in the northwestern and northeastern parts of the county. These knolls range from a few feet to 30 feet high, and the gradients range from 4 to 12 percent. A total area of 4,224 acres is mapped. Much of this soil occurs in the vicinity of Hope. Most of it was cleared of timber when the county was settled, and 6 percent of it remains in timber at the present time. The principal trees are sugar maple, black walnut, beech, ash, elm, hickory, and white oak.

In cultivated fields Miami silt loam is light brown when moist and light grayish brown when dry. The surface soil layer is a slightly gritty silt loam. The plow soil is platy and crumblike in structure, but it readily crushes to a flaky mass. At a depth of 7 to 10 inches the subsoil layer is lighter in color and contains less organic matter than the surface soil. The surface and subsurface soils are medium acid. At a depth of 10 to 26 inches the subsoil is light-brown to slightly yellowish-brown friable silty clay loam, the lower part of which is more compact than the upper part. The entire soil profile becomes less acid with depth until the brownish-gray calcareous clay loam is reached at an average depth of 28 inches. This parent-material horizon is about 20 to 30 percent carbonates of lime and magnesium. It consists of mixed sand, silt, and clay laid down by ice during the Late Wisconsin glacial period.

A few gravelly knolls of Bellefontaine loam and silt loam have been included with Miami silt loam, owing to their small area. These knolls are conical in shape, with steep hillsides, and occur in a few scattered areas. One of these areas is in section 2 in the northwestern part of the county. The pale-brown surface soil ranges from loam to silt loam and usually is less than 10 inches deep, owing to loss by erosion. The subsoil consists of strong-brown friable gravelly clay loam, which is underlain by gray calcareous gravel at a depth of 3 to 4 feet. In some places gravel for road surfacing and other uses is excavated from these areas.

The usual crop rotation consists of corn, wheat, and clover, with a small proportion of the land used for oats, soybeans, and miscellaneous crops. Land use data for the county indicate that 30 percent of Miami silt loam was planted to corn in 1935. Yields of corn average 5 bushels more to the acre than on Crosby silt loam, owing to good natural drainage conditions. Corn is grown on a smaller proportion of Miami silt loam than on the associated Crosby and Brookston soils, because sloping soil erodes readily when it is not covered by vegetation.

To grow oats successfully, it is necessary to seed early in the spring in order to escape drought and hot weather when the crop is maturing; therefore oats are grown on only 2 percent of Miami silt loam. Yields average about 30 to 35 bushels an acre.

Wheat is usually seeded in the standing corn in the fall. Some of the ground is previously prepared for wheat when the corn has been cut for silage; or wheat follows special crops, such as tomatoes and sweet corn. Yields of wheat range from 15 to 25 bushels an acre. Wheatland is generally fertilized with 125 to 150 pounds of 2-12-6 fertilizer. About 20 percent of Miami silt loam is used for growing wheat.

Medium red clover is most commonly grown. It is seeded during early spring in the small grain. Good stands of clover are easily obtained, because Miami silt loam is only medium acid in the surface soil and upper subsoil and only slightly acid in the lower subsoil. Owing to good natural drainage conditions, there is less damage from winterkilling than on the imperfectly and poorly drained soils. About 14 percent of the soil is used for hay and 10 percent for pasture. Because of its location on knolls and its good drainage, about 4 percent of this soil is used as farmstead sites.

Miami silt loam, eroded phase.—Because of the moderately steep slopes and the tendency of farmers to plant a rather large proportion of clean-tilled crops, such as corn, on Miami silt loam, much of the surface soil on the more sloping phase ranges from 0 to 7 inches in thickness, depending on the severity of the erosion. The underlying yellowish-brown or light-brown heavy subsoil is exposed to some extent on all the areas of the eroded phase, but in a few places gullies have cut as much as 2 feet into the subsoil layer. In other respects it is similar to the normal phase. A total area of 128 acres of the eroded phase is mapped. The agricultural value of this soil depends largely on how much surface soil remains. Because of the sweet subsoil, which is rather close to the surface, severely eroded areas of Miami silt loam are more easily rehabilitated than soils with poor, strongly acid subsoils. Lespedeza, clover, and grasses are grown to improve the fertility and to stop erosion. It is also common practice to use fields containing a good deal of this soil for permanent alfalfa meadow. Much of this soil is being planted to corn, wheat, and meadow, but yields are quite low. It is better suited to bluegrass pasture. Yields of corn range from 5 to 25 bushels an acre.

Miami silt loam, slope phase.—This phase is similar to the normal phase except that it occurs on slopes as steep as 15 to 25 percent. Because of the slope and susceptibility to erosion, it is not well suited to cropping; nevertheless only 9 percent has been kept in timber. Despite lower yields of grain crops, especially corn, 70 percent of this

phase is used for rotation crops, and 21 percent is devoted to bluegrass pasture. This soil is best adapted to use as pasture land. A total area of 128 acres is mapped.

Martinsville silt loam.—This soil occurs on level river terraces or benchlands. It is most extensive in Nineveh Creek Valley west of Edinburg, but there are scattered areas throughout the larger stream valleys. A total area of 1,856 acres is mapped. Practically all of this type has been cleared of timber and is being farmed.

The 12-inch surface soil is light-brown to grayish-brown mellow silt loam. With slight pressure it crumbles into fine particles that crush easily. It is moderately low in organic matter and moderately acid in reaction.

The 12- to 44-inch subsoil is a friable yellowish-brown silty clay loam, which becomes rather hard when it dries. In a few places where internal drainage is poor the subsoil below 30 inches is slightly mottled with gray. This part of the subsoil is usually heavier and the clay is more plastic and tough. At a depth of 44 to 60 inches the subsoil consists of more friable mottled gray and yellow mixed clay and sand. The parent material, at an average depth of 4 feet, consists of calcareous stratified clay, sand, and gravel of low carbonate content. The entire soil profile above the calcareous parent material is medium acid.

Corn and wheat are grown on 67 percent of this type. Wheat is considered to be slightly better suited to this soil than corn. Corn yields average from 40 to 45 bushels and wheat from 15 to 20 bushels an acre. Soybeans, sweet corn, and tomatoes are grown to a limited extent. A small proportion of the land is used for alfalfa and red clover. Owing to the acidity of the soil, liming is necessary to grow these crops successfully, especially alfalfa. As the chief crops are grain, only a small part of the land is used for pasture or remains in timber.

Martinsville loam.—This soil is similar in character to Martinsville silt loam. In a dry condition the 10- to 12-inch surface soil consists of weak-brown to light grayish-brown loam, and when moist it is brown. The subsoil, at a depth of 12 to 30 inches, is moderately heavy light-brown to brown clay loam, underlain by stratified sand, silt, and clay in the lower subsoil. The soil is medium acid to an average depth of 4 feet.

A few areas of Martinsville loam, slope phase, have been included with this soil. These inclusions occur on slopes of 10 to 30 percent, but the soils are not underlain with calcareous gray gravel, and gravel does not occur in the soil mass. The surface soil is pale-brown loam with a few areas of silt loam and fine sandy loam texture. It is underlain by brown silty clay loam or clay loam with more friable sandy and silty stratified material at depths of 3 to 5 feet or more.

The most extensive area of Martinsville loam occurs in the vicinity of Taylorsville and northeastward. Small areas are found throughout the valleys of all the principal streams. A total of 5,120 acres is mapped.

Corn, wheat, and clover or mixed hay, or corn, oats, wheat, and clover or mixed hay, are the crop rotations most commonly followed. Corn and wheat are the principal crops. Corn yields from 35 to

40 bushels and wheat from 15 to 20 bushels an acre. Owing to the more sandy surface soil and to subsoil conditions, the water-storage capacity is not so great as in the heavier soils, and corn yields may be reduced by lack of moisture when the corn is in the earing stage. As the supply of moisture is limited, more soybeans are being grown, largely for hay. Oats are grown to a limited extent, mainly for feed. Oats must be seeded early to obtain the highest yields. Martinsville loam dries early in the spring, allowing early tillage and seeding. Special crops, such as sweet corn, tomatoes, tobacco, and cabbage, are grown on a small part of this soil. In the vicinity of Taylorsville, corn for hominy is grown extensively. Lime is necessary to grow red clover, as the soil is quite acid. Clover is likely to be killed by drought because of the sandy texture and the low water-holding capacity. Most of the meadowland consists of mixed clover and timothy. In a few places where there is relief of about 10 feet between the terrace and adjoining overflow bottom land, erosion may occur under cultivation. A few acres of such soil are included with the Martinsville soils.

Milton silt loam.—This soil occurs on terraces from a few feet to 15 feet above the valley floor. In a few places it is not more than 2 feet below the upland level. This soil has been formed in part from alluvial deposits remaining after the great volume of water from the melting glacier had removed the glacial till from the limestone bedrock and in part from limestone. A total area of 960 acres is mapped. The largest areas occur in the valleys of Clifty Creek, Little Sand Creek, Duck Creek, and Tough Creek.

Milton silt loam has a smooth light-brown silt loam surface soil 8 to 12 inches thick, which rests on moderately friable light-brown silty clay loam at a depth of 17 inches. The lower subsoil consists of tough, waxy, slightly darker brown silty clay from 15 to 50 inches deep to bedrock. In areas where alluvial deposits of sand and silt have formed part of the parent material, the soil is more gritty and friable. In the valley adjoining the falls of Fall Fork the surface soil ranges from light loam to silt loam and the subsoil is also more friable, owing to alluvial deposits. The entire soil profile is only slightly acid in reaction. In a few places where the soil is sloping or is pitted by sinkholes there is a limited amount of sheet erosion.

General farm crops consisting principally of corn, wheat, and clover or mixed hay are grown on this soil. Corn yields about 35 bushels an acre where the soil is not eroded. Wheat and hay each occupy about 12 percent of this land. Kentucky bluegrass is naturally adapted to pastures. About 11 percent consists of idle land or low-grade pasture cover. Erosion may be controlled easily on sloping areas by the use of bluegrass pastures. About 4 percent of the land consists of woods.

As mapped, Milton silt loam includes a few areas with slope gradients of 15 to more than 25 percent. The surface soil ranges from light brown to slightly dark brown, indicating a slightly higher content of nitrogen and organic matter in some places than in the typical soil. Corn and wheat are grown on one third of this included soil, particularly on the more moderate slopes, and slightly lower yields may be expected because of sheet erosion. The slopes are best suited to pasture and timber. About one-third of this inclusion is used for pasture and one-third for woodland. The total area is very small.

Rugby silty clay loam.—The 12- to 15-inch surface layer is moderately dark brownish gray, neutral in reaction, and high in both organic matter and nitrogen. The subsoil consists of tough, waxy, smooth, yellowish-brown silty clay, also neutral in reaction. The soil is formed from bluish-gray limestone of the Sellersburg, Silver Creek (Devonian), and Niagara (Silurian) limestone formations. This limestone bedrock is from 12 to 30 inches deep. A total area of 256 acres is mapped, principally in the valley of Clifty Creek.

Rugby silty clay loam occurs on the steep lower slopes of the valley walls, and except for the gently sloping lower portions of the hillsides most of it is unsuited to farming. It is used mainly for timber and for bluegrass pastures. Alfalfa, corn, and truck crops are grown to some extent. Because of erosion cultivated crops can be grown only a few years, after which the land reverts to less intensive uses, such as alfalfa, mixed meadow, and bluegrass pasture. About 44 percent of the land consists of good-grade bluegrass pasture, 11 percent of poor-quality pastures, and 36 percent has never been cleared of timber.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the corn, wheat, and livestock area (1A) occur on the flat to gently undulating broad interstream divides, which are 1 to 2 miles wide. These soils comprise about 21 percent of the area of the county. They are brownish gray, rather low in content of organic matter, moderately acid in reaction, and require artificial drainage. As most of these soils are heavy in texture, it is necessary that considerable care be taken in tillage operations to promote a granular physical condition of the soil. In general these soils have mottled gray, dark-brown, and yellow heavy subsoils.

The soils in this group are Fincastle silt loam; Fincastle silt loam, shallow phase; Fincastle loam; Crosby silt loam; Delmar silt loam; Whitaker silt loam; Whitaker loam; Homer loam; and Zipp silty clay loam.

The crop rotation is similar to that on the well-drained soils, but a greater proportion of the land is in corn because of more level relief and the mixture of the darker colored soils with the soils of this group. A slightly lower proportion of such crops as oats and clover are grown than on the well-drained soils.

Fincastle silt loam.—This soil, with a total area of 23,872 acres, is the most extensive soil in the county. It is the principal soil throughout the southeastern part. Locally it is called clay land, and the associated Cope silty clay loam is called black land or gray loam. Large individual areas of Fincastle silt loam do not occur, because of the intimate mixture of black land in the swales and depressions and the associated morainic knolls of the Russell soils. Originally, fine forests comprising a great variety of trees, such as sugar maple, beech, American elm, ash, sweetgum, sourgum, and pin, white, and black oaks, covered this land.

Fincastle silt loam has a smooth, brownish-gray, fine granular surface soil 12 inches thick. Under air-dry field conditions it is light brownish gray. The content of organic matter is low, and the soil is medium to strongly acid. Under forest conditions the upper-

most 3-inch layer of soil was moderately dark and contained much organic matter. When the land was brought under cultivation this organic matter was mixed with the plow soil and the supply was rapidly depleted. Because of poor drainage conditions and the low content of organic matter the soil tends to puddle and bake easily under improper handling. The subsoil, to a depth of about 18 inches, consists of mottled gray and yellowish-brown moderately friable silty clay loam practically free of grit. From 18 to 32 inches in depth it is heavy, more compact silty clay that breaks into angular blocks ½ to 1 inch in diameter. Moisture movement in this portion of the subsoil is slow. Mottled gray and yellow gritty or pebbly calcareous clay, sand, and silt occur at an average depth of 44 inches. This material was deposited during the recession of the early Wisconsin glacier.

Fincastle silt loam, which occurs on the island ridge 3 miles northwest of Columbus, consists of more uniformly silty soil material in the upper 20 to 25 inches of the soil profile. This portion of the soil profile is almost entirely free of glacial pebbles. Probably it is formed partly from wind-deposited silts that have drifted here from adjacent terrace and bottom sands during and after the Late Wisconsin glacial period.

The crop rotation on Fincastle silt loam consists of corn, wheat, and clover or mixed hay. Corn is grown on 30 percent of the land, and yields average 35 to 40 bushels an acre. Wheat is grown on 24 percent of the land. It is seeded in the standing corn. Farmers commonly fertilize wheat with 150 pounds of a 2–12–6 mixture. The proportion of corn and wheat grown is slightly higher than on the well-drained associated Russell silt loam. The soil is medium to strongly acid and requires lime to grow red clover successfully. Hay is grown on 19 percent of the land, 17 percent of which is in red clover or mixed clover and timothy. A few farmers who apply manure and keep the soil on a high level of fertility grow clover satisfactorily without liming. Most of the meadows consist of mixed clover, timothy, and other grasses. Soybeans are grown on about 3 percent of the land. Yields range from 1 to 3 tons. About 7 percent of the land is used for pasture, most of which is of good quality.

Fincastle silt loam, shallow phase.—This phase occupies 6,720 acres. The largest areas are in the vicinity of Newbern and extend northeast into Decatur County. Smaller areas occur south of Newbern. It differs from the normal phase in the depth to which the more easily dissolved lime has been removed by water. The surface soil consists of brownish-gray smooth silt loam 10 to 12 inches thick, underlain by mottled gray and yellow heavy subsoil similar to the normal phase. The heavy impervious subsoil extends to the calcareous parent material, which occurs at an average depth of about 36 inches, without an intervening layer of more friable gritty subsoil.

The system of farming is similar to that on Fincastle silt loam except that more corn is grown. Corn and wheat yield about the same as on the normal phase. Red clover is more easily grown because the soil is not quite so acid.

Fincastle loam.—This soil occurs in scattered areas on and near the bluffs on the eastern side of the valleys of the Driftwood and East Fork White Rivers. A total of 320 acres is mapped. The principal

areas are north of Union Christian Church (northeast of Taylorsville), near Friends Church, and 2 miles north of Azalia.

Fincastle loam consists of a thin deposit of wind-blown sand on glacial still of the Wisconsin period. The dry surface soil of cultivated fields is light brownish gray. At a depth of 10 to 18 inches the subsoil is a mottled gray and yellowish-brown clay loam or silty clay loam, which is strongly acid in reaction. The depth to which the sand is mixed with the leached pebbly glacial still is variable, but it is usually less than 18 inches. The subsoil below a depth of 10 inches is a compact rusty-iron stained gray and yellow mottled silty clay. It is highly plastic and sticky when wet and is neutral in reaction. This material grades through more friable gritty material into calcareous grayish-yellow pebbly silty clay loam.

The crop rotation consists of corn, wheat, and mixed hay. The total percentage of various crops other than pasture does not differ greatly from that of Fincastle silt loam. Because of the acidity of this soil and the greater likelihood of damage resulting from drought, only a small proportion of the land is used for clover and mixed hay. Bluegrass is not well suited to this soil, therefore only a very small part of the land is used for permanent pasture. About 14 percent of the land is timbered.

Crosby silt loam.—This soil is third in extent of the imperfectly drained soils. A total area of 6.208 acres is mapped. It occurs in the northeastern corner of the county, where it is mixed with many-lobed swales of Brookston silty clay loam on the interstream divides and with Miami silt loam on the sloping areas along stream courses. Crosby silt loam was originally covered with a fine stand of deciduous forest. About 94 percent of it has been cleared and brought under cultivation.

The surface soil is brownish gray when moist and light brownish gray or gray when dry. The surface soil is a slightly gritty loam that crushes to fine crumblike particles. The low content of organic matter, with poor drainage and silty texture, causes the soil to puddle and bake readily under improper management. It is medium acid in reaction.

At depths of 8 to 12 inches the surface soil gives way abruptly to a mottled gray and yellowish-brown silty clay loam, which extends to a depth of approximately 17 inches. From this depth to the parent material the lower subsoil layer consists of a compact somewhat impervious mottled silty clay loam, which is quite plastic and sticky when wet and hard when dry. Calcareous mixed clay, sand, and some glacial pebbles occur at an average depth of 30 inches. The entire soil mass to a depth of 20 inches is medium acid in reaction.

A few small areas of more poorly drained light-colored soils have been included with Crosby silt loam. They have light-gray surface soils containing brown iron concretions, locally called turkey shot, scattered over the surface and throughout the soil. The subsoil has a rusty-iron stained gray color. The included areas are in sections 2 and 11, 2 miles northeast of St. Louis Crossing, and 1 mile east of Hope.

A mixed grain and livestock system of farming is followed on Crosby silt loam, with corn, wheat, and clover or mixed hay the

principal crops in a 3-year rotation. Somewhat more corn is grown because of the intimately associated small area of Brookston silty clay loam. Yields average from 35 to 40 bushels an acre. Wheat is usually seeded in the standing corn. About 150 pounds of a 2 12–6 fertilizer is applied to the land. When wheat follows soybeans, tomatoes, or sweet corn, the ground is disked prior to seeding. The yields average about 18 to 20 bushels an acre under average management. When the ground has been previously prepared, higher yields are obtained. In the spring medium red or mammoth red clover is broadcast in the wheat. The soil usually needs to be limed to obtain a good stand of clover. On unlimed land a mixture of clover and timothy is usually seeded. Clover usually yields 1 to 2 tons of hay an acre. When conditions are favorable for seed formation some of the clover is threshed for seed, and yields of as much as 4 bushels an acre have been reported.

Delmar silt loam.—This soil has a light-gray surface soil when dry. Round rust-brown iron concretions are commonly found on the soil. These concretions are indicative of long periods when the soil was wet, interspersed with short periods when the soil was dry. The upper subsoil layer, from depths of 12 to 18 inches, is iron-stained gray smooth silty clay loam. The lower subsoil layer, to a depth of 36 inches, is mottled gray, yellow, and rust-brown, tough, impervious silty clay. A zone of friable clay loam separates it from the calcareous mixed clay, sand, and glacial pebbles occurring at a depth of about 48 inches. In a few small areas the depth to lime is less than 3 feet. The soil is strongly acid to a depth of 40 inches. Delmar silt loam occurs in small nearly level areas scattered over the southeastern part of the county. A total area of 512 acres is mapped.

The cropping system on this soil is similar to that used on Fincastle silt loam, but the soil is less intensively used because of poor drainage conditions. Delmar silt loam is locally called beech land, as the original timber cover consisted largely of beech trees.

Whitaker silt loam.—Areas of this soil are scattered throughout the valleys of the principal streams, but the larger areas occur north of Taylorsville and in the vicinity of Clifford. A total area of 2,752 acres is mapped. When dry the surface soil of cultivated fields is brownish gray to a depth of 10 inches. The organic-matter content is low. The surface soil usually has a smooth silt loam texture, but in some places it is fine sandy loam. The soil is moderately acid in reaction. The upper subsoil layer, to a depth of 18 inches, is mottled gray and yellow smooth silty clay loam, which becomes heavier and more plastic with depth. Internal drainage is poor because of the heavy subsoil and the generally high water table. The lower subsoil layer, at a depth of 36 to 50 inches, is more friable and lighter in texture. It is composed of stratified layers of noncalcareous silt and fine sand. Beneath a depth of 60 inches the sand and silt layers are calcareous. The parent material consists of stratified deposits of sand, silt, and clay of the Late Wisconsin glacial period.

Although a mixed grain and livestock system of farming is generally followed, many of the farmers do not keep much livestock because of the limited supply of roughage and pasture. About 79 percent of the land is used for grain and special cash crops, 10 percent is in hay,

and 7 percent is in pasture land. Corn and wheat are the dominant crops, occupying respectively 37 and 33 percent of the land. The crop rotation followed consists of corn, wheat, and mixed hay or corn and wheat. Corn yields 35 to 40 bushels an acre, and wheat, which is usually fertilized, 15 to 20 bushels. As the soil is strongly acid, farmers have found that liming is necessary to insure a good stand of clover. Most of the meadows consist of mixed clover and timothy, which yield 1 to 2 tons an acre. Only 2 percent of the land is in woods.

Whitaker loam.—This soil differs from Whitaker silt loam principally in containing a larger quantity of sand throughout the soil profile. The surface soil is light brownish-gray gritty loam to loose mellow light loam. The upper subsoil layer consists of mottled gray and yellow clay loam that grades into plastic, tough, waxy, mottled silty clay loam. The lower subsoil layer consists of stratified layers of silt and sand. Below a depth of 5 feet the underlying parent material is calcareous. A total area of 2,560 acres is mapped. The most extensive areas occur along the east side of the East Fork White River Valley between Columbus and Azalia, but much of it is in small scattered areas.

Areas of Whitaker loam that occur in association with the Fox soils contain some gravel throughout the profile. The parent material consists of stratified gravel and sand, which in some places contains as much as 30 percent of carbonate of lime. Farming practices on Whitaker loam are about the same as on Whitaker silt loam, although a lower proportion of wheat and a higher proportion of drought-resistant crops, such as soybeans and alfalfa, are probably grown. Pasture is generally poorer in quality than that on Whitaker silt loam.

Homer loam.—This soil occurs in numerous small areas northeast and south of Columbus. A total area of 1,600 acres is mapped. This soil is associated with the Fox soils in long, narrow, slightly lower lying swales or depressions. It has a light brownish-gray friable loam surface soil, underlain at 10 to 12 inches by mottled gray and yellow moderately compact clay loam containing variable amounts of gravel. The subsoil below a depth of 3 feet becomes more gritty and friable and is usually underlain by fine gravel mixed with silt and clay. It is gray in color and contains 15 to 30 percent of carbonate of lime. Drainage is poor. Crop yields and land use are similar to those on Whitaker loam.

Zipp silty clay loam.—Several areas of this soil are mapped in the vicinity of Renner School (west of Taylorsville) and 1 mile west of Wagner School on Denois Creek. This soil lies in the valley on flat benchland a few feet above the flood plain. A total area of 64 acres is mapped.

The soil to plow depth is a slightly dark brownish-gray to gray silty clay loam. When the soil dries, cracks half an inch wide or more develop in uncultivated fields, which is an indication of the heavy texture and the high proportion of clay. When cultivated at the proper moisture content, the soil to plow depth crumbles to a loose granular consistency. Hard clods form when tillage operations are performed on the wet soil. At a depth of 10 inches the surface soil

grades into a mottled gray and yellow tough plastic silty clay subsoil, which becomes more yellow with depth. The surface soil is nearly neutral in reaction, and at a depth of 30 inches grades into calcareous subsoil. As mapped in this county this soil is not so poorly drained and does not have such dark-colored surface soil as in other areas in the State.

Zipp silty clay loam is a productive soil well adapted to the growth of most farm crops. Corn, which is grown on 32 percent of the land, yields from 40 to 60 bushels an acre. About 8 percent of the land is used for soybeans, which yield from 2 to 3 tons. Special crops such as sweet corn and tomatoes are extensively grown.

POORLY DRAINED DARK-COLORED SOILS

The poorly drained dark-colored soils of the corn, wheat, and livestock area were developed in elongated shallow depressions where swamp conditions prevailed almost permanently before the land was settled. Swamp forest trees and marsh vegetation, such as sedges, cattails, and reeds, grew luxuriantly and produced large quantities of organic matter, which gradually accumulated in the soil. As these soils occupy low, depressed positions, they acted as collecting places for the sediment and ground water that came from the higher land surrounding them. The alkaline ground water contained lime and other bases, which made these lower lying soils neutral in reaction and fixed or held the organic matter so that it was not leached from the soil. Mineral matter washed from the higher land helped to fill the swales and was mixed with the organic matter, producing a rich, dark-gray surface soil from 12 to 20 inches thick. When drained these soils are highly productive, because they are neutral in reaction and have an abundant supply of organic matter and nitrogen. When pioneers settled in this county some of the less marshy areas were covered with mixed stands of deciduous trees. As these were the richest soils, these areas were soon cleared and drained and brought under cultivation. Practically all of these soils have been artificially drained.

About 95 percent of the poorly drained dark-colored soils comprising this group occur in the grain and livestock district, and all of them will be considered in this group even though a few small areas are in the general farming district. Wherever they occur in areas large enough to dominate the use of the land they are used largely for corn and to a less extent for hay, pasture, and wheat.

The soils in this group are Brookston silty clay loam, Cope silty clay loam, Westland silty clay loam, Westland loam, Abington silty clay loam, Lyles silty clay loam, Lyles loam, and Carlisle muck.

Brookston silty clay loam.—This soil type occurs in the many-lobed swales and depressions throughout the northeastern part of the county, in association with the Miami and Crosby soils. It occurs also on the broad interstream divides where natural drainageways have not been developed. Because of the mixture of Brookston and Crosby soils, fields have a spotted black and light-gray appearance; consequently the soils are commonly referred to as black and clay land.

Brookston silty clay loam has a dark-gray to very dark brownish-gray granular surface soil from 12 to 15 inches thick. The soil to plow

depth is frequently not quite so dark as the subsurface soil, because of some light-colored Crosby material washed in. The surface soil ranges from a silty clay loam to a silty clay where it occurs in the deeper parts of the swales. Farmers call the heavy-textured soil gumbo. The structure of Brookston silty clay loam is easily damaged by tilling the soil when it is wet or by cattle trampling the wet soil. When properly handled the cultivated soil has a loose granular structure. The large quantity of organic matter keeps the small soil aggregates apart and causes them to break readily under pressure. The surface soil ranges from neutral to slightly acid.

The subsoil is mottled gray and yellow silty clay. It becomes hard when dry and breaks into large angular clods. At a depth of 3 to 5 feet calcareous pebbly silty clay is found. The subsoil is neutral in reaction. About 3,648 acres of this soil is mapped.

A few areas that have a darker surface soil and a greater accumulation of organic matter than the typical soil are included with Brookston silty clay loam. This dark layer usually continues to a depth of about 22 inches. The subsoil in such areas is bluish-gray silty clay with some rust-iron stains. Such areas occur in the deepest and wettest parts of the depressions and would be separated on the map as Clyde silty clay loam if the area were larger.

Brookston silty clay loam has an abundant supply of organic matter, nitrogen, and moisture. It is adapted to the growth of corn. Corn yields 50 bushels or more to the acre, usually without the use of fertilizer or manure. It is the common practice for farmers to apply manure to the associated less productive light-colored soils. The most common rotation consists of corn, wheat, and red clover or mixed hay. The proportion of the land used for each of these crops is 37, 25, 10, and 7 percent, respectively. Only 4 percent remains in timber, and most of the timbered areas have not been drained.

Wheat yields about 20 bushels an acre, which is comparable to the yields on the light-colored soils. However, the yields may vary, because considerable winterkilling may result in some years, owing to the low position and poor drainage, and some may be lost through lodging just before harvesttime. An abundant supply of plant nutrients is available if a good stand of wheat survives the winter.

Brookston silty clay loam is a highly productive soil for hay crops because of the abundant supply of moisture. Since it is nearly neutral in reaction, little difficulty is experienced in obtaining good stands of red clover; but the proportion of red clover grown is rather low, because of the damage from heaving and winterkilling, resulting from poor drainage. Mixed clover and timothy are most often grown. The yields range from 1½ to 2½ tons an acre. About 90 percent of this soil is under cultivation, and it is especially good for such crops as sweet corn and tomatoes, which yield about 5 and 10 tons, respectively. These crops are followed by wheat, which is seeded on the disked ground after the crop has been harvested.

Cope silty clay loam.—This soil is associated with the Fincastle and Russell soils. It occupies slight depressions and is very similar in many respects to Brookston silty clay loam. It usually occurs in small areas, often at the head of drainageways. The depressions are not so long, wide, and deep as those of the Brookston soil. The soil is usually lighter in color and somewhat lower in organic matter. The texture

ranges from silty clay loam to silt loam. This soil is also slightly more acid and less productive than Brookston silty clay loam.

As mapped, many areas of this soil are identical with Brookston silty clay loam. This is particularly true in the broader swales and more extensive areas such as occur south of Newbern. A total area of 12,224 acres is mapped.

Westland silty clay loam.—This soil occurs in elongated swales and depressions, associated with the Martinsville and Homer soils; a few areas are associated with the Homer and Fox soils in the gravel plain. The largest areas are located north of Taylorsville and in the vicinity of Clifford. A total area of 3,520 acres is mapped.

The texture of Westland silty clay loam varies from smooth silty clay loam to clay loam containing a considerable quantity of sand and some gravel. It is easily kept in granular condition, and clods are easily crushed in tillage. The moderately dark-gray surface soil is about 17 inches thick. The subsoil is moderately heavy silty clay loam, which is plastic and sticky when wet. Below a depth of 36 inches stratified clay, sand, and occasionally gravel may be found. Mixed clay and gravel are more likely to occur in the subsoil of areas that are closely associated with the Fox soils. The entire soil profile is neutral to slightly alkaline in reaction. Stratified calcareous gravel and sand of Wisconsin age occurs below a depth of 5 feet.

In some places a systematic crop rotation of corn, wheat, and clover is followed, but Westland silty clay loam is usually used for such crops as corn and wheat, each of which occupies about one-third of the total area. Soybeans, tomatoes, and sweet corn are grown to a limited extent on about 10 percent of the soil. Owing to abundant supplies of available plant nutrients and moisture, corn yields about 50 bushels or more to the acre. Wheat is likely to be winterkilled to some extent because of excess moisture. Low-lying, very poorly drained areas are frequently used for pasture. Soybeans are grown to a considerable extent because they may be seeded late on the more poorly drained areas.

Westland loam.—This soil is similar to Westland silty clay loam in general appearance. It has a dark-gray surface soil and a mottled gray and yellow subsoil. The surface soil contains sufficient silt and clay to cohere well, but hard clods do not form when the soil is tilled in a wet condition. The subsoil is friable silty clay loam. The soil was formed under swamp conditions from water-laid gravel, sands, silts, and clays of Wisconsin glacial origin. It is tilled and managed similarly to Westland silty clay loam. Westland loam occurs in swales and depressions on the river terraces, associated with Homer and Martinsville soils. The largest areas occur northeast of Taylorsville and in the vicinity of St. Louis Crossing. A total of 448 acres is mapped.

Corn, wheat, and soybeans are grown on 26, 20, and 6 percent, respectively, of the soil, but the soil is also adapted to such crops as tomatoes and sweet corn. A small part is used for pasture. Like the other dark-colored soils, it has been almost entirely cleared of the original timber cover and brought under cultivation.

Abington silty clay loam.—Areas of this soil are mapped in the lowest, most poorly drained portions of the depressions of the terraces. It is associated with the Westland and Homer soils. A total of 320 acres

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is mapped. The largest areas are 1 mile east and 5 miles north of Columbus in sections 17 and 20, respectively, and 2 miles south of St. Louis Crossing in section 22.

Abington silty clay loam differs from Westland silty clay loam in having a darker colored surface soil containing more organic matter. This dark layer is 20 inches thick and ranges from clay loam to smooth silty clay. The heavy-textured areas are locally called gumbo. The subsoil is drab gray, indicating more sluggish internal drainage.

Probably owing to poor drainage, a higher proportion of this soil has been kept in timber than any of the other dark-colored soils. Corn, wheat, and, to a more limited extent, hay are the principal crops grown. It is a highly productive soil, although some crops, such as wheat, may be winterkilled.

Lyles silty clay loam.—This soil is a dark-colored soil developed in the depressions associated with Princeton and Ayrshire soils. In most places it occurs on terraces. The soil is partly developed from stratified water-laid sands washed largely from the adjoining Princeton soils and partly from wind-blown material. Because of the similarity to Brookston soils in soil character and use, it is discussed here. It is rather variable in texture because of the washing and shifting of sand and silt.

The dark-gray to medium-gray surface soil is underlain by mottled gray and yellow silty clay loam or loam at a depth of 18 inches. The organic-matter content decreases with depth. Clods form readily, but they break easily, owing to the sand content and organic matter. The soil grades into more friable sandy substrata at a depth of 4 to 5 feet. The entire profile is neutral in reaction. Corn, wheat, tomatoes, and cabbage are very well adapted to this soil. Corn yields 50 bushels an acre, tomatoes 8 to 12 tons, and cabbage 12 to 15 tons. Hay crops and pasture are better adapted to this soil than the small grains. Frequently the use of the soil is determined by the larger areas of associated light-colored soils, and small grains are grown. A total area of 384 acres is mapped, mainly in the vicinity of Columbus on the east side of the East Fork White River Valley.

Lyles loam.—Lyles loam occurs in the same general area and is associated with the same soils as Lyles silty clay loam. The surface soil ranges in texture from a fine sandy loam to a heavy loam. The land is tilled easily because the soil crumbles readily into a loose mellow seedbed. The soil is moderately dark gray, neutral in reaction, and well supplied with plant nutrients and moisture. The system of farming, crop adaptations, and productivity are similar to those on Lyles silty clay loam. A total area of 512 acres is mapped.

Carlisle muck.—A few areas of Carlisle muck occur in the county. These areas formerly were permanent marshes or ponds. In these places the soil material is largely derived from sedges and marsh grass, with a very low proportion of mineral matter. It consists of granular, loose, spongy, thoroughly decomposed and macerated organic matter, which is usually saturated with water. It is black to dark gray and slightly acid to neutral in reaction. Below a depth of 25 to 30 inches gray silty marl or carbonate of lime usually occurs. A total area of 64 acres is mapped in two abandoned channels of Flatrock Creek. One of these is 1½ miles southwest of St. Louis Cross-

ing and the other is 1 mile north of Columbus in section 12. Because of poor drainage this soil is used mainly for pasture, although where drained it is well suited to corn, potatoes, and special crops.

WHEAT AND LIVESTOCK AREA

The wheat and livestock area (1B) is made up of the gravel plains or terrace lands of the river valleys. Wheat is the principal crop, but corn, sweetclover, alfalfa, and some special crops are also grown. The Fox soils, which represent the dominant series, are underlain by calcareous gravel at a depth of 3 to 6 feet. Some of the sandy members of the Martinsville series have been included in this subdivision, because the limited moisture-holding capacity makes them better suited to wheat than to corn. They are rather droughty for corn but are excellent for growing wheat. Dairying is an important enterprise, as there is an adequate supply of roughage, and corn is plentiful on the adjoining river-bottom soils.

WELL-DRAINED SOILS

Probably more than 95 percent of the soils of the wheat and livestock area is very rapidly drained, so that such crops as corn suffer from the usual midsummer drought. The soils have only moderately heavy subsoils containing considerable quantities of gravel and sand. They are underlain at a depth of 3 to 6 feet by loose gravel or sand that has a very low moisture-holding capacity. Soybeans, sweetclover, alfalfa, wheat, and rye are best adapted to these soils. Soybeans are not seriously damaged by drought. The roots of alfalfa and sweetclover can penetrate deeply into the subsoil for their moisture requirements. Wheat and rye require the most moisture in the spring, when there is an abundant supply of water in the soil.

The soils in this group are Fox loam, Fox gravelly loam, Fox silt loam, Fox sandy loam, Nineveh loam, Nineveh gravelly loam, and Martinsville fine sandy loam. The Fox soils are underlain with abundant supplies of hard, round gravel that is well-suited for road building. Most of the gravel pits were opened within 4 feet of the surface. When the gravel is no longer suitable for road-building purposes the pits are abandoned. Sweetclover is the only crop that will grow on the banks of the pits.

Fox loam.—This is the dominant soil of the gravel plains or terrace lands found throughout the broad valleys of Flatrock Creek and the Driftwood and East Fork White Rivers. It is the principal soil of the wide gravel terraces extending northward from Columbus, known as the Haw Patch. Originally the Fox soils were covered by forest consisting of hackberry, ash, walnut, sugar maple, and black, red, and chestnut oaks. Because of the flat relief and the well-drained, productive soil, nearly all of this land is now used for crops and pasture. The small acreage of timber remaining consists of large trees with a dense ground cover of Kentucky bluegrass.

The 10-inch surface soil of Fox loam is brown to slightly dark brown and is strong brown in moist cultivated fields. The organic-matter content is low, even under forest conditions. Because of the loose, granular condition of the cultivated soil, the organic matter is oxidized more rapidly than on the heavier soils. The texture of the

surface soil ranges from a gritty silt loam or heavy loam to a loose mellow loam. Sand particles of all sizes, including a little gravel, are mixed with the soil. Fox loam is medium acid, but there are some areas that are neutral in reaction. One of these areas occurs on the low terraces at the junction of Flatrock Creek and the Driftwood and East Fork White Rivers. Areas of Fox loam that are slightly dark may be nearly neutral in reaction.

The upper subsoil layer is a dull yellowish brown that becomes stronger brown with depth. It is rather hard when dry but breaks into angular particles one-quarter to one-half inch in diameter when wet. From a depth of 18 inches to the parent material the subsoil contains a considerable quantity of rounded glacial gravel embedded in the yellowish-brown clay loam, which becomes quite plastic and sticky when wet. The subsoil ranges from moderately to slightly acid. A dark-brown, neutral, sticky clay horizon, 6 to 8 inches thick, has been developed at the contact with the calcareous parent material, which consists of assorted gray sand and gravels containing numerous granite, gneiss, jasper, and other exotic rocks of glacial origin.

Fox loam occurs in extensive flat areas broken by an occasional swale or sandy knoll. A total area of 14,400 acres is mapped.

Plate 1 is an aerial view including a typical section of the Haw Patch, or gravel terrace, near Columbus.

The usual rotation on Fox loam is corn and wheat. Wheat is seeded in the standing corn, and early in the spring sweetclover is seeded in the wheat, to be plowed under the following spring in order to maintain the organic-matter content of the soil, which is then planted to corn. A systematic rotation is not followed on much of this soil. Wheat occupies 32 percent of the land. In Flat Rock Township wheat is grown on 40 percent of this soil. Wheat is fertilized with 150 to 250 pounds of a 2–16–6 fertilizer. Yields range from 20 to 45 bushels an acre.

Corn is grown to a less extent than wheat because good yields are uncertain on land with a low moisture-holding capacity. Corn is quite dependent on rainfall during the tasseling stage; and as rainfall is rather low during July and August, the yield is from 20 to 60 bushels an acre, probably averaging about 35 bushels.

Soybeans and alfalfa, because of their drought resistance, are important hay crops. Red clover is frequently killed by drought. A small acreage is devoted to mixed clover and timothy. As sweetclover and alfalfa require a sweet soil, lime is commonly applied at the rate of about 2 tons an acre every 8 to 10 years for these crops.

Kentucky bluegrass grows well on the Fox soils. Nearly all the bluegrass pastures and the wooded pastures are covered with a dense stand of this grass. Many of the dairymen and stockmen supplement their permanent pastures with temporary pastures of Italian ryegrass or Sudan grass to be used during July and August.

Many farmers diversify their farming system by raising special crops, such as tomatoes, burley tobacco, sweet corn, and strawberries. Tomatoes, which are sold to canneries at Columbus and Edinburg, yield 7 to 10 tons an acre. They are usually fertilized heavily. Tobacco is grown on small plots of from 2 to 5 acres and is sold on the Madison and Louisville markets.

Aerial photograph of Columbus, Ind., and vicinity, including part of the Haw Patch to the north. *A*, Northeastern part of Columbus; *B*, Haw Patch, or gravelly bench-land (Nineveh and Fox soils); *C*, junction of the Driftwood River and Flatrock Creek forming East Fork White River; *D*, dark-colored soils of old glacial channels on the gravel terrace (Westland and Abington soils); *E*, overflow bottom land (Genesee and Eel soils); *F*, sand dune area, comprising Princeton and Ayrshire soils together with small areas of Russell loam, developed partly from dune sand and partly from glacial till

Fox gravelly loam.—This soil occurs along the boundary between the terrace and the overflow bottoms of Flatrock Creek northward from Columbus and along the Clifty Creek bottoms east of Columbus. The relief in such places is usually less than 15 feet, and the slopes range from 10 to 30 percent. They are neither steep enough nor wide enough to preclude cultivation entirely. A total area of 512 acres is mapped.

Fox gravelly loam is associated with and similar to Fox loam except in the relief and the surface texture. The surface soil ranges from loam to gravelly loam. It usually contains some gravel, and in many places under cultivation the light-brown surface soil has been washed away, exposing the gravelly reddish-brown clay loam subsoil. This soil is used about the same as Fox loam, although it is better suited to hay, pasture, or timber than to cultivated crops, because of the damage from sheet erosion.

Fox silt loam.—This soil occurs in narrow, shallow, serpentine swales, which are remnants of old drainage lines. It is well drained but not so rapidly drained as the lighter textured Fox loam. As it occurs in slight swales, it receives a little more moisture than the associated Fox loam, because the water flows into it from the higher ground. The soil contains more silt and clay and consequently has a higher moisture-holding capacity.

This soil is brown when wet. The 12-inch surface soil consists of gritty silt loam, which is friable and easily kept in a mellow condition. The subsoil is a friable reddish-brown silty clay loam or clay loam, underlain by calcareous gravel at a depth of 4 feet. A total of 1,408 acres is mapped.

Fox silt loam is usually farmed like the associated Fox loam, because it occurs in small areas. Corn averages about 10 bushels more to the acre than on Fox loam and consequently is grown on a slightly larger proportion of the land.

Fox sandy loam.—This soil occurs on sandy knolls and flat areas, associated with Fox loam. A total of 1,024 acres is mapped. The larger areas occur east of Columbus and south of Garden. It has a mellow, light-brown surface soil 12 inches deep, which ranges from a fine sandy loam to a sandy loam containing considerable quantities of medium and coarse sand. Some of the fine sandy loam is rather uniform in texture, and this fact, together with its knolly relief, indicates that it was in part deposited by the wind. The subsoil ranges from light reddish-brown gravelly clay loam to gravel-free clay loam at a depth of 30 to 35 inches. Much of it is probably underlain by limy gravel at a depth of 5 to 8 feet. A few acres of Fox gravelly sandy loam are included with this soil on the soil map. This inclusion is similar in all respects to the typical soil except that small rounded gravel occurs in all layers.

On many small areas the use of this soil is determined largely by the associated Fox loam, but its sandy surface soil and the low moisture-holding capacity have resulted in some striking differences in use. Yields of corn average 5 to 10 bushels less to the acre than on Fox loam, nevertheless more corn than wheat is grown. Yields of wheat probably average 17 bushels an acre on Fox sandy loam. Drought-resistant crops, such as soybeans, rye, alfalfa, and sweetclover, are well adapted to and extensively grown on this soil.

Nineveh loam.—This soil resembles Fox loam except that it is slightly darker brown throughout the soil profile and has slightly more organic matter and is also less acid. It occurs in several large areas in the vicinity of Columbus and north of Taylorsville. A total area of 3,136 acres is mapped.

Nineveh loam has a dark-brown, mellow surface soil, 10 inches deep. Cultivated fields are dull brown rather than the stronger brown of Fox loam. North of Taylorsville several well-drained, shallow, dark-colored swales having a silt loam surface soil were included in this separation. The surface soil is slightly acid in reaction. The subsoil is slightly darker brown than that of Fox loam; when crushed it is brown. At a depth of 18 to 30 inches is a friable clay loam containing some rounded glacial gravel. This layer becomes quite hard when dry. At greater depths the soil is more sandy and gravelly, and the calcareous gray gravel is reached at an average depth of 4 feet. A dark-brown, neutral, very sticky gravelly clay layer occurs at the contact with the limy gravel. The surface soil and the subsoil are only slightly acid.

The agricultural practices on Nineveh loam are similar to those on Fox loam except that corn is more productive. In Flat Rock Township, 76 percent of this land is used for corn. The greater depth to gray, loose gravel and the higher organic-matter content probably increase the moisture-holding capacity. Corn yields from 35 to 45 bushels an acre. The soil is well suited to all the other crops grown in this area, although lime is needed to grow some legumes.

Nineveh gravelly loam.—The 10-inch surface soil is dark brown, is neutral in reaction, and contains more gravel than the typical Nineveh loam. The friable gravelly clay loam subsoil at a depth of 20 inches is underlain by calcareous gray gravel and sand. Because of the loose gravel occurring close to the surface, such crops as corn suffer from drought to a greater extent than on the Nineveh loam. Despite this deficiency, corn is the dominant crop, occupying 37 percent of the land, with wheat second, having 26 percent of the acreage, and there is a small area in red clover. Corn yields average about 25 bushels an acre. Alfalfa and sweetclover are well suited to this soil, because it is neutral in reaction. The crops are able to thrive on the limited supply of moisture that is available. Wheat and rye make good yields on this soil.

Small scattered areas of this soil occur on gentle slopes of 3 to 5 percent, intermingled with Nineveh loam and members of the Fox series. A total area of 576 acres is mapped. Near Newbern and in Clifty Creek Valley along the Johnson County line several areas of the soil mapped had rounded glacial rocks or cobbles 3 to 6 inches in diameter scattered over the surface and throughout the soil profile.

Martinsville fine sandy loam.—This soil occurs as flat to undulating terraces of the East Fork White River and associated large stream valleys. The largest areas are in the vicinity of Jonesville, where the soil occurs as a flat plain associated with smaller areas of Martinsville loam. A total area of 2,240 acres is mapped.

Martinsville fine sandy loam is a loose, mellow, sandy soil, derived from water-laid sand and silt of the Wisconsin glacial period. This soil is sufficiently sandy to be rather poorly adapted to crops that require a good deal of moisture, such as corn. The surface soil con-

sists of light-brown fine sandy loam that is moderately acid in reaction. Because of the rapid absorption of rainfall, the soil dries quickly, and tillage operations can be performed early in the spring. Plowing when wet tends to bind the sand and clay particles together and improve the physical condition of the soil. The organic-matter content is very low. Rye and sweetclover may be used as green-manure and soil-improvement crops to increase the organic and nitrogen content and moisture-holding capacity. The subsoil consists of light-brown heavy loam to a depth of 18 inches which, when dry, is rather loosely cemented and crumbles easily under pressure. From a depth of 18 to 40 inches the subsoil is moderately heavy light-brown clay loam, underlain by stratified loose fine brown sand with occasional layers of silt.

Wheat and rye are the best adapted of the small-grain crops. Wheat is grown on 39 percent of the soil and with an application of 125 to 250 pounds of commercial fertilizer yields from 10 to 15 bushels an acre. Corn is grown on only 24 percent of the land. In seasons of abundant rainfall corn yields as much as 45 bushels an acre, but the average yield is about 28 bushels. Soybeans for hay are grown on about 10 percent and alfalfa and clover or mixed hay on 8 percent of the land. Because of the acidity of the soil, it is necessary to lime it to grow alfalfa or sweetclover. Kentucky bluegrass is not well adapted to very sandy soils, consequently the pastures are rather low grade and quite weedy. Tomatoes and some truck crops, including melons, are grown to a limited extent.

AREA OF SPECIAL CROPS AND GENERAL FARMING

In the area of special crops and general farming (1C) the soils are developed on low dune sands bordering the eastern side of the East Fork White River Valley. Light-colored sandy soils are interspersed with dark-colored moderately heavy soils. Because of the mixture of soils with varied crop adaptations, the agriculture of this area consists in growing special crops and practicing general farming along with dairying and livestock and poultry raising. The most extensive area, in the vicinity of Azalia, is used for growing watermelons and cantaloups and for general farming. In addition to melon culture, the soil is well adapted to sweetpotatoes and early tomatoes.

WELL-DRAINED SOILS

The well-drained soils of the special crops and general-farming area have an irregular dune relief consisting of low ridges, extending in a north to northwesterly direction, separated by irregular elongated depressions or flats. The soils were developed under a fine stand of mixed timber consisting of tuliptree, hickory, oak, elm, ash, and walnut. Most of the land has been cleared and brought under cultivation. These soils originally contained only medium quantities of organic matter. The organic-matter content is difficult to maintain under cultivation because of the permeable, well-aerated character of the soil. These soils were formed from uniformly assorted deposits of sand laid down thousands of years ago by strong northwesterly winds that carried the sand from the adjacent river valleys to the bluffs on the east sides of the valleys. The soils in

this group are Princeton fine sandy loam; Princeton fine sandy loam, slope phase; and Princeton loamy fine sand.

Princeton fine sandy loam.—This is the principal soil of the area. The 12-inch surface soil consists of pale-brown loose fine sandy loam. It is low in organic matter and contains very little clay to cause the sand particles to cohere when dry. The subsoil from 12 to 30 inches consists of brown to somewhat yellowish-brown friable clay loam or sandy clay loam. The texture of the subsoil ranges from a loose loamy fine sand to a moderately heavy clay loam. Below a depth of 30 inches loose yellowish-brown sand occurs, and this is underlain by calcareous yellowish-gray sand at an average depth of about 50 inches. A total area of 3,200 acres is mapped.

Because rainfall is readily absorbed by the sandy surface soil, rather steep slopes may be cultivated without much damage from erosion. Slopes of 15 to 20 percent gradient are frequently cultivated. Because of the low moisture-holding capacity, it is difficult to follow a systematic crop rotation. Corn and wheat are the principal crops grown. Corn yields usually average about 25 bushels an acre, although with abundant rainfall much higher yields may be obtained. Wheat yields average about 10 to 15 bushels an acre. The meadows are usually seeded to mixed clover and timothy, because red clover is frequently killed by drought. Meadows tend to "run out" in a few years and become weedy. Drought-resistant crops, such as soybeans, alfalfa, and sweetclover, are best adapted to this soil. Pastures are usually poor, as the sandy soil is not well suited to bluegrass.

This soil is naturally adapted to the growth of special crops. Many watermelons and cantaloups are grown, principally in the vicinity of Azalia. Early tomatoes, which command the higher prices of the early marketed vegetables, may also be grown successfully, as the soil warms quickly in the spring and thus promotes rapid growth.

Princeton fine sandy loam, slope phase.—A few areas of Princeton fine sandy loam have slopes that are so steep as to interfere with general-farming operations, and the soil is classified as a slope phase. The slopes, ranging in gradient from 15 to 40 percent, occur along the bluffs on the east sides of large streams such as Clifty Creek east of Columbus. Because of the ready absorption of rainfall and the lack of serious erosion, steeper areas of this phase can be cultivated than of the heavier textured soils. About 50 percent of the soil has been kept in timber, and the rest is used as crop and pasture land. Wheat is the principal crop and occupies 21 percent of this phase. Crop adaptations are similar to those on the normal phase. A total area of 256 acres is mapped.

Princeton loamy fine sand.—This soil consists of loose, mellow, pale-brown loamy fine sand surface soil underlain by yellowish-brown fine sand extending to calcareous gray sand at an average depth of 5 feet. A total area of 128 acres is mapped. Corn is the principal crop, although the average yield is lower and the crop is more likely to suffer from drought than on Princeton fine sandy loam. More than half as much wheat is grown as on Princeton fine sandy loam, and twice as much of the land is in hay. Old meadows are usually weedy and give very low yields. This soil is well suited to soybeans and alfalfa and is possibly even better suited to melons than Princeton fine sandy loam.

IMPERFECTLY DRAINED SOILS

Ayrshire loam.—This is the only light-colored, imperfectly drained soil in the group of soils used for special crops and general farming (1C). It occurs on low flats and isolated depressions in association with Princeton soils. The larger flats may be tile-drained easily, but it is economically impractical to drain the small depressions surrounded by the Princeton soils unless they are connected to natural drainageways.

The surface soil of Ayrshire loam is gray to light gray when dry and brownish gray when wet. It is low in organic matter, and the heavier areas bake under improper handling. The surface texture varies from a fine sandy loam to a silt loam. The surface soil contains sufficient sand to make it crumble easily when cultivated. The subsoil, at a depth of 10 to 33 inches, is a rust-stained mottled gray and yellow clay loam or silty clay loam. It is quite compact when dry and is plastic and sticky when wet. The subsoil, from a depth of 33 inches to the underlying calcareous sand, consists of more friable mottled loam. The entire profile is strongly acid. During periods of excess rainfall undrained areas of Ayrshire loam become quite wet because the ground-water level is raised by drainage water from surrounding high ground. Internal drainage is poor, owing to the tight subsoil. A total area of 1,280 acres is mapped.

The principal crops are corn, wheat, and clover and mixed hay. Wheat is frequently winterkilled in depressions, but it can be grown on flat areas not covered by standing water. Soybeans and tomatoes are minor crops that are well suited to this soil, as they can be planted late in the spring after the soil has dried.

CASH-GRAIN AREA

The cash-grain area (1D) includes the level overflow bottoms of Flatrock Creek and the Driftwood and East Fork White Rivers and their tributaries. The soils are neutral in reaction and rich in plant nutrients and are among the most fertile soils in the State. The moisture-holding capacity is high enough to produce large corn crops in most years. Corn is the principal crop grown, and most of it is sold as grain. Practically no livestock is kept except a small number of work animals. Tractors are more commonly used for tillage operations than horses.

A systematic rotation is not followed on the bottom land. Corn is the highest yielding crop and the most profitable under average conditions and so is grown continuously until the yield declines or weeds become troublesome; wheat or soybeans are then usually seeded. This change is most commonly made at intervals of 5 to 7 years. Crops seeded in the spring and harvested in the fall are less likely to be damaged by overflow, as summer floods are rare. The number of floods each year in the large bottoms varies considerably from year to year. Under average conditions lower lying areas may be flooded a dozen times a season, while the highest parts of the overflow bottoms are not subject to more than 1 or 2 floods a year. Crop losses from flooding are reported to be small.

Soybeans are frequently seeded on the lowest and wettest land late in the spring after it is too late to plant corn. About one-third of

the soybeans seeded on the bottom soils are harvested for hay, and the rest for grain. Wheat is usually seeded on the higher ground close to the stream, as water is less likely to remain for prolonged periods after overflowing. Alfalfa is grown on the natural levees or higher land adjoining the streams and on the high bottoms, because there is the least possibility of damage on these areas. Good stands may be maintained for about 4 years, after which the fields are likely to be overrun by Kentucky bluegrass.

The crops grown on the bottom lands are largely marketed as grain, but on a few farms that are operated with adjoining higher land a grain-livestock system of farming is followed. Special cash crops, such as tomatoes, cabbage, tobacco, and melons, are grown to a limited extent. The bottom soils were originally covered with a fine stand of mixed timber. The most common varieties of trees are sycamore, elm, ash, soft and hard maple, cottonwood, tuliptree, walnut, oak, beech, and gum. Probably 7 to 9 percent of the bottom lands are now timbered.

WELL-DRAINED SOILS

The well-drained soils of the cash-grain area occupy about 90 percent of the total area. The flat relief and the rich soils have resulted in almost complete utilization for farm crops. The small proportion of imperfectly drained soils found in this area occur in depressions or swales. The well-drained soils are Genesee silt loam; Genesee silt loam, high-bottom phase; Genesee loam; Genesee loam, high-bottom phase; Genesee fine sandy loam; Genesee silty clay loam; Ross silty clay loam; and Ross loam.

Genesee silt loam.—This is the most extensive soil in the cash-grain area. A total of 10,176 acres is mapped. It occurs throughout the valleys of the larger streams and in some of the small bottoms. The weak-brown mellow surface soil is easily kept in a mellow physical condition because of the organic-matter content and a moderate content of fine sand. The surface soil grades into a slightly lighter yellowish-brown friable subsoil at a depth of 10 to 15 inches. The subsoil ranges from silt loam to light silty clay loam. Seams or strata of fine sand that were deposited during different floods may be found throughout the subsoil. These bottom soils are locally called made land, because of the deposition of silt and sand, which comes with each overflow period. They are also called sycamore soils.

Corn and wheat are the principal crops. Soybeans, alfalfa, and truck crops, such as tomatoes and cabbage, are well adapted but are grown to only a limited extent. Corn is grown on about 45 percent of the soil. In the broad river bottoms it is the principal crop. Fertilizer is not generally used, as the soil is inherently rich. Yields range from 45 to 90 bushels an acre, with an average of about 55 bushels.

Owing to the large supply of nitrogen, Genesee silt loam is not so well adapted to wheat as to corn. Wheat frequently lodges before harvest. It is grown on 21 percent of the soil, but there are many variations among townships. In Clay and Flat Rock Townships about as much wheat as corn is grown, whereas in the small bottoms very little is grown. Wheat is frequently fertilized. Yields average about 18 bushels an acre. Excellent yields of alfalfa are obtained, although there is more danger of its drowning out in floods than on the sandy

types of Genesee soils, which occupy slightly higher positions in the bottom. As this soil is naturally adapted to Kentucky bluegrass, alfalfa fields are usually overrun by this grass in a few years. About 11 percent of the Genesee silt loam is used for pasture, much of which is wooded. Bottoms, which do not favor the use of power machinery, are used for pasture. These pastures frequently include the broken land along the bottoms.

Genesee silt loam, high-bottom phase.—This phase is a minor soil, with an area of only 512 acres. It occurs at a level of 2 to 5 feet above the normal phase; it is not high enough, however, to be generally used for farmsteads. Most areas are very similar to Genesee silt loam. The surface soil is weak brown and mellow and grades into a friable slightly lighter colored subsoil that is lower in organic-matter content. In a few brown or yellowish-gray areas gravel is found in the subsoil below a depth of 20 inches. On such areas corn is less productive. Crops are more frequently planted in rotation on this phase. About 50 percent of the soil is used for wheat and 25 percent for corn. Because of the protection from overflow, alfalfa is more extensively grown than on the typical soil. Almost all the soil is cropped.

Genesee loam.—This soil type has a mellower surface soil than Genesee silt loam, because of the moderate quantities of sand that it contains. It is weak brown in color, and it grades into a yellowish-brown friable silty clay loam or clay loam subsoil at a depth of 15 inches. As much of it occurs on natural levees along the principal streams, 20 percent has been kept in timber, principally that in old channels or in places where the stream is cutting into the bank. A total area of 3,520 acres is mapped in small areas scattered along the larger streams.

A larger proportion of this soil than of Genesee silt loam is in pasture and timber; alfalfa is widely grown, as it is less likely to be drowned during floods than on Genesee silt loam. Corn, the principal crop, occupies 39 percent of the soil and wheat 13 percent. Crop yields are slightly lower than on Genesee silt loam.

Genesee loam, high-bottom phase.—This phase is similar to Genesee loam except that it occurs on a slightly higher level, intermediate in position between the more frequently overflowed land and the benchland. The character of the soil and the crop yields are similar to those of the normal phase. The weak-brown mellow loam surface soil grades into lighter brown slightly heavier subsoil that is several feet in depth. In a few places gravel occurs 2 feet below the surface. A total of 256 acres of this phase is mapped in small areas throughout the bottoms.

This high-bottom phase is more intensively used than Genesee loam. Owing to the higher position with less crop loss from overflow, wheat, alfalfa, mixed hay, and special crops, such as tomatoes, are more extensively grown. Soybeans are grown to some extent, chiefly owing to the lower water-holding capacity of the soil.

Genesee fine sandy loam.—This soil occurs as natural levees in the curves or oxbows of the larger streams, where the water sweeps out of its banks during floods. The speed of the current is retarded, and sand is deposited. The 10- to 15-inch surface soil is brown to weak-

brown fine sandy loam or loamy sand, which grades into loose lighter brown fine sand at a depth of about 3 feet.

In a few small areas where the river leaves its banks during floods a considerable quantity of fine gravel and in places also some coarse and medium-sized sand particles occur in the surface soil. A total area of 384 acres is mapped.

Like Genesee loam, much of this fine sandy loam is used for timber and pasture. About 20 percent of it is kept in woodland to prevent stream cutting. Corn, the principal crop, is grown on 50 percent of the land, although yields average only about 35 bushels an acre. Wheat is the only other crop of importance. Alfalfa is grown to only a limited extent, although the soil is naturally adapted to it. Some watermelons and cantaloups are grown on the loose sandy areas.

Genesee silty clay loam.—This soil is most extensively developed in the East Fork White River Valley south of Columbus. A total area of 1,344 acres is mapped. The 10-inch surface soil is a weak-brown to dusky-brown smooth silty clay loam, which dries to a slightly brownish-gray color. The texture is a moderately smooth silty clay loam, some of which contains a small quantity of very fine sand. If it is plowed or tilled when wet hard clods form and are not easily broken. Below a depth of 12 inches the subsoil consists of a yellowish-brown friable silty clay loam. Corn and wheat are the principal crops. Excellent yields are obtained on this soil. On levee-protected areas, which are not so susceptible to overflow, wheat is grown in rotation with corn.

Ross silty clay loam.—This soil occupies a high-bottom position and so is subject to flooding only about once or twice a year on the average. Because the surface soil is moderately dark-colored, this soil is locally known as black land or mulatto land. The surface soil is rich in organic matter and moderately high in nitrogen. The moderately dark color gradually fades until at an average depth of 22 inches the subsoil is dusky brown to pale brown. In the air-dry condition the plow soil is moderately dark gray. The soil to plow depth consists of a smooth silty clay loam, which is quite friable if tilled properly, but hard clods form if the soil is too wet when tilled. The subsoil is a tough, rather waxy, silty clay loam in the upper part and is moderately friable below 30 inches. The entire soil mass is neutral to slightly alkaline in reaction.

Areas of Ross silty clay loam are interspersed with swales of Eel silty clay loam throughout the valleys of Flatrock Creek and the Driftwood and East Fork White Rivers. A total area of 3,200 acres is mapped.

This soil is almost completely used for crops; a small part is in timber or bluegrass pasture. Corn and wheat are the principal crops and are usually grown in rotation. Corn yields an average of about 50 bushels an acre and wheat 18 bushels. Soybeans for both hay and grain, alfalfa, tomatoes, and sweet corn are grown to some extent, and either red clover or sweetclover is occasionally seeded for hay or for soil improvement. Because of the slight elevation of this soil—2 to 5 feet above the overflow bottoms—crop losses are seldom sustained.

Ross loam.—A few small scattered areas of this soil occur throughout the river bottoms. The largest areas are near the junction of the

East Fork White River and Little Sand Creek. Ross loam has a dusky-brown surface soil containing enough sand to make it work easily. It grades into a pale-brown to weak-brown friable subsoil at a depth of 20 inches. Corn is considerably more important than wheat on this soil. Crop yields are slightly lower than on Ross silty clay loam. About 128 acres of this soil is mapped.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the cash-grain area represent about 45 percent of the overflow bottom soils. They are brownish gray in color, neutral in reaction, have a moderate supply of organic matter, and are highly productive where they have adequate drainage. Owing to the low, flat position, in most places it is impossible to obtain adequate fall for artificial drainage. Open ditches are used to a limited extent. This group of soils includes Eel silty clay loam, Eel silt loam, Eel loam, Shoals silty clay loam, and riverwash.

Eel silty clay loam.—When moist, this soil has a brownish-gray mellow silty clay loam surface soil. To maintain granular structure, tillage operations must be performed when the ground is not too wet, otherwise hard clods will form. The soil is neutral in reaction and rich in plant nutrients. The surface soil grades into a brownish-gray heavy silty clay loam subsoil, which is mottled gray and yellow brown at an average depth of 20 to 22 inches. A total area of 7,488 acres is mapped.

Eel silty clay loam occurs in low, narrow swales and is usually farmed with the surrounding Genesee and Ross soils. Early corn is occasionally drowned out and has to be replanted. Yields of corn average 50 to 60 bushels an acre.

Soybeans, and occasionally turnips, are seeded in swales of Eel silty clay loam after the surrounding well-drained land has been planted to corn. Because of the greater crop hazard, the proportion of idle land is slightly greater than on the associated soils. Wheat is seeded on about 25 percent of this soil. As it is seeded in the fall, the flood hazard is much greater than on associated soils, and therefore the yields average only about 15 bushels an acre.

Eel silt loam.—In addition to being one of the soils of the cash-grain area (1D), this is also the dominant soil of the small stream bottoms in the corn, wheat, and livestock area (1A). It is similar to Eel silty clay loam in all respects except that its surface soil is a brownish-gray, rather smooth silt loam. In some places it contains a small quantity of very fine sand. At a depth of 10 to 12 inches the surface soil grades into slightly lighter colored brownish-gray silt loam that contains slightly less organic matter than the surface soil. Below depths of 18 to 24 inches the subsoil is mottled gray and yellowish brown, owing to slow internal drainage. A total area of 8,320 acres is mapped.

Eel silt loam is not so completely or intensively used as Eel silty clay loam, because much of it occurs in narrow valleys, which cannot be farmed efficiently. Crop yields are similar to those obtained on Eel silty clay loam. About 25 percent of the soil is used for corn, 16 percent for wheat, 10 percent for red clover and mixed meadows, and a small part for soybeans and truck crops. The small bottoms used

as pastures comprise one-fourth of the land, and forests about one-tenth.

Eel loam.—This soil type differs from the other members of the Eel series in the texture of the surface soil. Both the surface soil and the subsoil contain variable quantities of sand, which insures excellent physical condition. In other respects, including agricultural use and crop yields, it is similar to Eel silt loam. A total area of 704 acres is mapped. Much of it occurs in the small stream bottoms of the special crops and general-farming area (1C). Corn and wheat are the principal crops. About one-third of the land is used for pasture.

Shoals silty clay loam.—This soil occurs principally in the valleys of Haw Creek and Tough Creek. A total area of 832 acres is mapped. The soil is somewhat darker and more plastic than Eel silty clay loam, and tillage operations require considerably more power. This soil is locally known as gumbo. It is used mainly for corn, wheat with some soybeans, hay, and truck crops. The pastures consist largely of marsh grasses and sedges with a small proportion of white clover.

When wet the surface soil is a moderately dark gray that becomes a medium gray when the soil is dry. Clods formed by plowing the soil when wet are very difficult to crush. Immediately below the soil to plow depth the subsoil becomes a mottled bluish-gray and yellow-brown tough waxy silty clay.

A few areas of Shoals silt loam occur in low back bottoms in abandoned channels of the East Fork White River and its larger tributaries. These inclusions generally are brownish gray to dull rusty gray and are less plastic and sticky than the typical soil. The clay content of the surface soil and of the subsoil is lower, and in a few places there is a silt loam mixture. Owing to the low positions of these areas, artificial drainage is difficult or impossible, and they are used only occasionally for crops. Late-planted crops, such as soybeans, can be grown most satisfactorily, although corn may also be grown successfully on some of the better drained areas.

Riverwash.—Riverwash comprises sand and gravel bars occurring principally in the channels of the larger streams, such as the East Fork White and Driftwood Rivers. Occasionally this material is deposited adjacent to the channel during overflow or along recently cut stream channels. The material consists of light-gray or yellowish-gray sand and gravel, which is occasionally suitable for road building or other purposes but has no agricultural value. A total area of 64 acres is mapped.

SOILS OF THE GENERAL-FARMING DISTRICT

According to figure 3, the farming followed in district 2 is subdivided into general-farming areas (2A) and hill-farming and forestry areas (2B).

The products of the general-farming area are largely poultry, eggs, cream, and some special crops, such as tomatoes, green beans, and sweet corn. Corn and wheat are the principal grain crops; but small acreages of rye, soybeans, and timothy are also grown. The most extensive farming operations are on the Illinoian till plain. About 35 percent of the area is used for rotation crops and 22 percent as timberland, and the rest is in low-grade pasture or idle land.

The general-farming district consists of a level glacial till plain that has been dissected moderately by streams and a hilly area of soils developed from acid sandstone, siltstone, and shale.

GENERAL-FARMING AREA

The general farming area (2A) has well-developed dendritic drainage patterns that have been formed in the till plain, with shallow tributary streams cutting deeply into nearly all the interstream divides. Well-drained soils occur in narrow irregular strips along the courses of streams. Steep or rolling well-drained soils adjoin the stream bottoms, and as the relief flattens away from the streams drainage conditions become poorer. Broad divides of imperfectly drained soils occur southwest of Columbus. Northwest of the city the area is completely and thoroughly dissected.

WELL-DRAINED SOILS

The well-drained soils of the general-farming area are strongly acid in reaction and very low in nitrogen, organic matter, and general soil fertility. The more sloping land suffers from erosion, and the level land requires artificial drainage for efficient farming. In general, the land use is characterized by a large proportion of timber on the steep and sloping areas and on the very poorly drained flat land, and a large proportion of idle land or very low-grade pasture on the arable land. About one-third of the entire area is used for farm crops. The farms are small, and the acreage of crops harvested per farm is low. Corn and wheat are the principal crops. On each farm some general-purpose cows are kept, and milk, cream, or butter are additional sources of income. Poultry and truck crops also provide a part of the farm income. Several successful commercial apple orchards have been developed on the rolling ground.

About 80 percent of the upland soils of the area are well drained. The soils in this group include Gibson silt loam; Gibson silt loam, slope phase; Haubstadt silt loam; Haubstadt silt loam, slope phase: Pekin silt loam; Cincinnati silt loam; Cincinnati silt loam, shallow phase; Cincinnati silt loam, eroded phase; Cincinnati silt loam, gullied phase; Cincinnati silt loam, steep phase; Parke silt loam; and Elkinsville silt loam. These soils are all light-colored and low in organic-matter content and were developed under a mixed forest. The dominant varieties of trees now are red, black, and white oak, shellbark and pignut hickory, beech, sugar maple, ash, and elm.

Gibson silt loam.—This is the most extensive soil of the well-drained group. A total area of 11,712 acres is mapped. It occurs on flat to gently sloping land of 0 to 6 percent gradient. In the thoroughly dissected part the soil occupies the rounded irregular many-lobed ridges. In the southern, less dissected part of the plain it occurs as narrow irregular strips adjoining the sharp breaks in the upland along the streams. Originally this soil was completely covered by a mixed stand of timber that included beech, sugar maple, red maple, pin and white oak, red gum (sweetgum), black tupelo (black gum), elm, ash, and hickory. Although this is one of the better agricultural soils of the area, 18 percent of it has been kept in timber.

Gibson silt loam has a smooth, mellow, brownish-gray or grayish-yellow surface soil 12 inches thick. It dries to a light brownish gray. It has a phylliform (thin-platy) structure and falls apart into flaky particles, which under slight pressure crush to a single powdery mass. Because of the low organic-matter content and the fine texture, the soil to plow depth bakes or packs rather hard after heavy rains. Newly seeded crops such as soybeans occasionally have trouble breaking through the crust that forms after rains. At a depth of 12 to 21 inches the upper subsoil is friable pale-yellow silty clay loam. Below this depth it grades into a mottled gray and yellow heavy subsoil, which is moderately compact and hard when dry. From 30 to 38 inches is a very compact strongly acid claypan, which impedes the movement of ground water. This layer is capped by light-gray silt, which covers the columns of weak-brown silty clay loam. The lower subsoil layer gradually becomes more friable and less mottled with depth. The calcareous parent material consists of a moderately compact heterogeneous mixture of clay, silt, sand, and glacial gravel, which was deposited during the Illinoian glacial period. The depth to which lime has been removed by leaching averages about 10 feet.

Spring seeding operations throughout this area are usually later than in other parts of the county, because the soil does not dry quickly. Owing to the gently sloping relief of Gibson silt loam, surface drainage removes much of the excess rainfall. The claypan in the subsoil retards internal drainage.

The entire soil profile is strongly acid, and soybeans and lespedeza are the only leguminous crops that can be grown without the use of lime. Soybeans are grown principally as a hay crop, and they yield from 1½ to 2 tons an acre. Common lespedeza volunteers in many meadows and pastures. Korean lespedeza is seeded to some extent as part of a mixture of grasses for meadows. Farm crops are grown on 35 percent of this soil, and corn and wheat occupy 14 and 10 percent, respectively. Corn averages about 25 bushels an acre, and wheat 12 to 14 bushels. Where lime has been applied, a rotation of corn, wheat, and mixed hay is followed. About 4 percent of the soil, one-half of which may have been limed, is used for clover and mixed hay. Where lime has not been applied, meadows are allowed to lie idle several years. About 11 percent of this soil is idle land covered by annual weeds and 28 percent is covered by broomsedge, poverty grass, and ticklegrass, which provides low-grade pasture. Farmers do not need much roughage, because relatively few livestock are kept in the area. When meadows become weedy they either lie idle or are used for pasture. When livestock is kept from this land, briers, sumac, persimmon, hickory, and oak sprouts eventually come in and reforest the land. Some tomatoes and sweet corn are grown near Columbus and Edinburg. Tomatoes usually receive an application of barnyard manure and average about 6 tons an acre.

Gibson silt loam, slope phase.—This phase occurs on the slopes of the Illinoian till plain. These slopes are arable and range in gradient from 10 to 16 percent. A total area of 8,064 acres is mapped, most of which occurs in the more moderately dissected portion of the till plain.

This slope phase is similar in most respects to the normal Gibson silt loam. The surface soil is brownish-gray smooth silt loam. At

a depth of 10 to 30 inches the subsoil is a friable yellow silty clay loam, underlain by a compact impervious mottled gray and yellow siltpan layer about 12 inches thick. This heavy subsoil layer is probably due in part to a higher proportion of shale in the parent material. The underlying material grades through less mottled and more friable gritty silty clay loam to the calcareous gray and yellow glacial till, which lies at depths of 8 to 10 feet.

Under cultivation the slope phase of Gibson silt loam is subject to rather severe sheet erosion. The surface soil is slightly browner than the normal phase, owing to better surface drainage conditions, and the subsoil in some places is a somewhat brighter yellow. Internal drainage is retarded by the claypan layer, which causes mottling in the subsoil at depths of 18 to 22 inches.

The crops grown are similar to those on Gibson silt loam. Owing to the erodibility of the soil, 30 percent of it has been kept in timber. Small grains and grasses are better suited than corn and soybeans for controlling erosion.

Haubstadt silt loam.—This soil occurs principally in one area around Ott School, where it occupies a very high terrace position. It is developed from stratified silts and clays, 15 to 20 feet thick, deposited on Illinoian glacial till. A total area of 576 acres is mapped.

Haubstadt silt loam is similar to Gibson silt loam, except that it has been developed from assorted water-deposited silts and clays. The surface is level to gently sloping where it adjoins streams. The surface soil consists of smooth brownish-gray silt loam and is underlain by pale-yellow to yellow friable silty clay loam at a depth of 12 inches. Below 20 inches the subsoil is a mottled gray and yellow tough impervious siltpan layer, which occurs at an average depth of 30 inches. The lower subsoil layer consists of friable yellow silty clay loam, with stratified layers of silt and sand at a depth of 5 to 7 feet. The entire profile is strongly acid to a depth of 70 inches or more.

A 3-year crop rotation is more widely used than on Gibson silt loam. Corn, wheat, and clover and mixed hay are grown on 15, 12, and 11 percent, respectively, of this soil. Approximately 40 percent of the soil consists of idle and low-grade pasture land, and 12 percent is timbered.

Haubstadt silt loam, slope phase.—The slope phase of Haubstadt silt loam is similar to the normal phase, but it has a slope ranging from 5 to 20 percent or more, probably averaging about 13 percent. This soil normally has a slightly more brownish-gray surface soil than Haubstadt silt loam, but the subsoil is moderately compact yellow silty clay loam, underlain by compact impervious siltpan at a depth of 3 feet.

Variations in the degree of slope have resulted in some variation in the color of the subsoil. The steeper areas are likely to have a brighter, more brownish color in the subsoil. Under cultivation the surface soil varies in thickness, depending on the degree of erosion. In some places it is entirely removed and the yellow subsoil exposed.

Only a small part of the soil is cultivated, and 77 percent of it has been kept in the original timber cover. Wheat and hay are the principal crops. A total area of 576 acres is mapped.

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Pekin silt loam.—This soil occurs on low alluvial terraces associated with Elkinsville soils along all the small streams throughout the western part of the county on the Illinoian till plain. The surface of the land is from 2 to 4 feet above the adjacent bottoms. The soil is developed from acid silt and clay deposits of mixed Illinoian drift and residual origin.

Pekin silt loam has a brownish-gray acid surface soil 10 to 12 inches thick, underlain by yellow to pale-yellow friable silty clay loam, which becomes mottled with gray at an average depth of 20 inches. The subsoil is not so compact as that of Haubstadt silt loam, and the siltpan where present retards internal drainage. Below 3 feet the soil becomes more friable, with stratified silts and clays occurring at 5 to 7 feet. The entire profile is strongly acid to a depth of 70 inches or more. A total area of 3,008 acres is mapped.

Corn and wheat are the principal crops. Clover or mixed hay are grown in a 3-year rotation where liming has been followed. Nearly 40 percent of the type is used as low-grade pasture or is idle land, and about 12 percent has been kept in the original timber cover.

Cincinnati silt loam.—This soil type occupies rolling land bordering the Knobstone escarpment. The slope is as much as 15 percent, consequently erosion is a serious problem where cultivated crops are grown. Some of the soil occurs on coarse-textured glacial till deposit, which provides good internal drainage. A total area of 3,072 acres is mapped.

The 7- to 12-inch surface soil is weak brown to pale brown. Fields in some places have a brown color when the soil is wet. The subsoil at a depth of 12 to 34 inches is friable light brownish-yellow silty clay loam. A moderately compact siltpan layer 8 to 10 inches thick is developed here and retards internal drainage to some extent. This layer has slight mottling and is streaked with gray silt along the vertical cleavage planes. The subsoil becomes more friable and gritty with depth until the calcareous glacial till is reached, at an average depth of about 9 feet. The entire profile down to the parent material is strongly acid.

Owing to severe erosion and decline of fertility, only 23 percent of the land is now cropped. Corn and wheat are the principal crops, and corn yields 25 to 30 bushels and wheat 12 to 15 bushels to the acre. About 44 percent of this soil is idle or abandoned land or land covered by broomsedge and poverty grass. Some of this land is reverting to forest.

Cincinnati silt loam, shallow phase.—This phase is similar to the normal Cincinnati silt loam in the upper 3½ feet. The surface soil consists of a weak-brown to pale-brown mellow silt loam 10 to 12 inches thick, underlain by a light brownish-yellow friable silt clay loam subsoil. In some places slight mottling occurs below a depth of 25 inches, owing to compact heavy subsoil at an average depth of 3 feet. Small rounded glacial gravel, consisting largely of chert, quartzite, quartz, jasper, and occasionally a crumbling granite rock, may be found throughout the profile. The subsoil becomes more friable below 40 inches. Interbedded sandstone and shale occur at depths of 4 to 8 feet. A total area of 1,088 acres is mapped.

Because the land is rolling, this soil is subject to severe sheet erosion when cultivated. Only 19 percent of this phase is used for farm crops,

and 48 percent is either waste land, idle land, abandoned land, or very low-grade pasture land with a cover of broomsedge and poverty grass. About 10 percent of such land is reverting to forest.

Cincinnati silt loam, eroded phase.—Areas of this phase are scattered throughout the Illinoian till plain. A total area of 832 acres is mapped. Because of erosion, this phase has less than 7 inches of surface soil. The more severely sheet-eroded areas occur on 15-percent slopes, which are at present or have been cultivated. About one-third of this phase is used for crops, but the yields are low. Idle land and broomsedge pastures are becoming the dominant uses and include about 40 percent of the soil. A cover of grass is stabilizing the erosion on many of the slopes. Common lespedeza and black locust are best adapted for reclaiming these areas. Both are legumes, which will build up the nitrogen and organic-matter content of the soil so that other plants will grow and prevent further destructive erosion. Much of the land is suited only for forestry. The subsoil is similar to that of the normal soil.

Cincinnati silt loam, gullied phase.—This phase occurs in numerous small areas or as narrow strips around the crests of hills. Much of the surface soil has been removed by sheet erosion, and numerous gullies have cut into the light brownish-yellow subsoil. Some areas bordering the sandstone hills may have rock within 4 to 6 feet of the surface. In most of these areas no attempt has been made to control erosion. They are suited only for forestry or pasture. A small part of this soil is used for crops, and more than three-fourths of it consists of idle or broomsedge pasture land. A total area of 1,344 acres is mapped.

Cincinnati silt loam, steep phase.—Areas of this phase occupy steep areas of 15 to 40 percent gradient. Most of the land is covered with a mixed stand of hardwood timber. About 15 percent of this phase is tilled, and the rest is used for forestry and pasture. Pasture grasses are of low nutritive value and consist largely of broomsedge, ticklegrass, poverty grass, and some bluegrass and lespedeza. Probably the best use of this soil is for forestry. A total of 5,952 acres is mapped.

Parke silt loam.—This is a well-drained flat to moderately rolling upland soil, underlain by a reddish-brown slightly sandy subsoil at a depth of 40 to 70 inches. The 12-inch surface soil consists of pale-brown smooth mellow silt loam that becomes somewhat reddish brown when moist. The subsoil is friable light reddish-brown silty clay loam at an average depth of 40 inches. At depths of 80 to 100 inches yellowish-brown heavier till may occur.

Areas of this soil occur 3 miles from the west county line in sections 24 of T. 9 N., R. 4 E., and 19 of T. 9 N., R. 5 E., and in section 5, 1 mile northwest of Ott School. This is a strongly acid soil, which is usually farmed about the same as the Cincinnati silt loam. Owing to good natural drainage conditions, alfalfa is well adapted if the soil is limed heavily. A total area of 128 acres is mapped.

Elkinsville silt loam.—This is a level well-drained soil developed in low alluvial terrace positions throughout the small stream valleys in the Illinoian till region in the western part of the county. This soil has a weak-brown to pale-brown acid surface soil, 10 to 12 inches

thick. It is underlain by a brownish-yellow friable silty clay loam subsoil, which is also acid. Below a depth of 3 feet the subsoil becomes more friable and in some places is slightly mottled in color. Stratified silt and very fine sand layers occur in some places at a depth of 5 to 7 feet. This soil occurs in small areas associated with the Pekin and Bartle soils.

A few areas of moderately sloping ground that occur as narrow strips along streams have been included with this soil. Such areas are similar to Elkinsville silt loam, but under cultivation moderate erosion has exposed the yellowish-brown subsoil in many places. A total of 320 acres is mapped.

Corn, wheat, and clover are the principal crops. Probably about 40 percent of the soil is under cultivation, and the rest is used largely as low-grade pasture land.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the general-farming area have level to very gently sloping relief and generally occur in narrow irregular strips between the level and the rolling ground. Internal drainage is poor, owing to a siltpan layer about 3 feet below the surface. A small part of the rainfall flows over the very gently sloping surface to nearby streams. Owing to the favorable relief, these soils are more completely utilized than the poorly drained soils of the flats. Because they are not susceptible to erosion, they are utilized more completely than the adjoining fairly well-drained soils. The soils in this group are Avonburg silt loam, Dubois silt loam, and Bartle silt loam.

Avonburg silt loam.—This is the most important soil in the group of imperfectly drained soils. It occurs throughout this area as nearly level land on the rounded ridges and adjoining stream valleys and has a total area of 7,552 acres.

The 10- to 12-inch surface soil is smooth light brownish-gray silt loam. A few round brown iron and manganese concretions, locally known as turkey shot or buckshot, are commonly found. Imperfect drainage conditions and the low content of organic matter cause the soil to puddle and bake under improper management. When heavy rainfall occurs following the seeding of such crops as soybeans, many of the seedlings are unable to break through the crust. To a depth of 17 inches the subsoil is mottled gray and yellow heavy silt loam that in many places breaks into small subangular particles about one-fourth inch in diameter. This material grades through a slightly heavier mottled layer to a light-gray floury silty layer, which in turn caps a columnar siltpan layer extending from a depth of 30 to 40 inches. The underlying subsoil becomes more friable, gritty, and yellow with depth. A few glacial pebbles may be found throughout the soil, but they are more numerous below 50 inches. The entire profile is very strongly acid to within a short distance of the calcareous grayish-yellow mixture of clay, silt, and gravel, which occurs at average depths of 9 to 10 feet.

This is the most intensively utilized of the upland soils in this group. About 85 percent of it has been cleared and was at one time farmed. Corn and wheat, the principal crops, occupy 17 and 11 percent, respectively, of the soil. Corn yields about 25 bushels an acre. Commercial fertilizer is not widely used except on wheat. Rye is grown instead of

wheat on a few farms, principally for use as hog feed. Soybeans yield from 1 to 2 tons an acre. Red clover, timothy, and mixed hay are grown on 6 percent of the soil. Liming is not generally practiced, but the 2 percent of the soil that is in clover probably represents the part that has been limed. As clover cannot be grown on unlimed land, few farmers follow a systematic rotation including the growth of legumes. Timothy and redtop are commonly seeded in the meadow mixture. The meadows run out after a few years, and grasses are replaced by broomsedge and poverty grass. About 34 percent of the land is in idle land or broomsedge pasture. The probable carrying capacity of such pastures is about 1 animal unit for each 5 to 8 acres.

This soil type responds well to tile drainage, but a very small part of it has been drained. Surface drainage is encouraged by plowing in narrow lands. Corn planting is frequently delayed a week or more because of spring rains. The stand of wheat is usually very thin, owing to winterkilling.

Dubois silt loam.—This soil is derived from acid highly leached assorted silts and clays of Illinoian glacial age. In the vicinity of Ott School it occurs on very high terraces, where characteristics of the soil, land use, and crop yields are similar to those of the Avonburg silt loam occurring on nearly the same elevation. A total area of 192 acres is mapped. Dubois silt loam requires artificial drainage for the most efficient farming. Very little of it is drained, but most of it has adequate slope for drainage.

A greater proportion of this soil than of Avonburg silt loam has been cleared, and it is more intensively used. Corn and wheat, the principal crops, occupy 22 and 19 percent, respectively, of the soil. There is a slightly higher proportion of hay, indicating that there may be more adherence to a systematic crop rotation.

Bartle silt loam.—This soil is developed from the same kind of acid silts and clays as the Elkinsville, Pekin, and Peoga soils. It occurs as alluvial terraces in the Illinoian glacial area throughout the western part of the county, which in general are 1 to 5 feet above the associated overflow bottoms of small streams. It differs from the Dubois silt loam in the degree of soil development and the elevation of the terraces above the overflow bottoms. It is more silty and stratified. Some areas are subject to occasional overflow. The soil has about the same acidity as the Dubois silt loam and is as low in productivity.

The surface soil consists of light brownish-gray friable silt loam, which is usually covered by variable quantities of rusty-iron concretions. The subsurface soil is light gray and low in organic matter, with gray and yellow mottlings occurring at a depth of 12 inches. At 3 feet a moderately impervious siltpan layer is generally developed, although it is not always present. Below 5 to 7 feet there is a medium-acid fine sand and silt strata. The soil profile is strongly acid to a depth of 5 feet. A total area of 3,520 acres is mapped.

The agricultural adaptations and yields of this soil are similar to those of the other soils of this group, although a higher proportion of it probably has been cleared of the original timber cover. Corn and wheat are the principal crops. Red clover and other leguminous hay crops are grown to a certain extent where the soil has been limed.

VERY SLOWLY DRAINED LIGHT-COLORED SOILS

The very slowly drained light-colored soils of the general-farming area consist of Clermont silt loam and Peoga silt loam. They are light gray, low in organic matter, and strongly acid, and are locally known as slash land, white clay, and buckshot land. The land is level and has no surface drainage, and internal drainage is poor because of an impervious siltpan layer at a depth of about 3 feet.

Originally the flats were covered with a fine stand of mixed timber, but all of them have now been cut over. The most common species remaining are pin oak and redgum (sweetgum). Black tupelo (black gum), beech, red maple, sugar maple, ash, and elm are of some importance. One-fourth of these soils are timbered, and many of the woods have 20 percent or more of the ground cover composed of trees of merchantable size.

Corn is the principal crop. Second-grade pasture consists principally of broomsedge and poverty grass. The proportion of idle and broomsedge pasture land to cropland increases as the slope of the land increases. A much greater proportion of the poorly drained Clermont silt loam is timbered than of the associated soils.

Clermont silt loam.—This is the more important of the two soils in this group. It has a total area of 7,744 acres, occurring principally on the broad divides in the southwestern part of the county. When moist it has a mottled very light brownish-gray surface soil, which dries to a light-gray or ashy-gray color. The soil is a smooth, floury silt loam that puddles and bakes badly. Under forest conditions the upper 3-inch layer is moderately dark gray, owing to the penetration of organic matter; but this is mixed through the soil at plow depth when the land is cultivated. The organic-matter content is very low. Iron concretions are numerous on the surface and scattered throughout the subsoil.

Below a depth of 12 inches the subsoil grades through a rusty-iron stained light-gray heavy silt loam or light silty clay loam and at a depth of 17 inches through a more compact slightly heavier subsoil to the siltpan layer at a depth of 36 inches. Loose floury white silt caps the tough impervious columnar silty siltpan, which impedes moisture movement through the profile. Below the siltpan layer, which extends to an average depth of 42 inches, the subsoil becomes more friable, gritty, and mottled yellow. The soil is strongly acid in reaction nearly down to the limy parent material, which occurs at a depth of 10 feet. This layer consists of moderately compact mixed grayish-yellow clay, silt, sand, and exotic glacial gravels.

Clermont silt loam, as it occurs on the broad flat divides, is ineffectively utilized, for a number of reasons. Artificial drainage, either by tiling or by dead furrows, is necessary for crops to grow successfully. This soil is more completely utilized as cropland on small areas than on large areas, because the small areas are more easily drained. In extensive areas probably less than 10 percent of the land is used for corn. Yields average about 20 to 25 bushels an acre on undrained land and about 40 bushels on drained land.

Wheat is grown on about 9 percent of the soil. Yields average about 10 bushels an acre on undrained land and 18 bushels on drained land. No systematic rotation can be followed on the unimproved

land because of frequent crop failures and uniformly low yields. Clover cannot be grown without the use of lime. Where lime has been applied at the rate of 2 tons or more to the acre, a rotation of corn, wheat, and clover or mixed hay is usually followed. Wheat in rotation is usually fertilized with 150 to 250 pounds of 2–12–6 fertilizer. Soybeans are grown to some extent for hay.

Peoga silt loam.—This soil is developed from noncalcareous stratified and assorted silts and clays of low stream terraces in the area of Illinoian glacial till. The 12-inch surface soil consists of light-gray smooth silt loam, underlain by a light-gray rusty-iron stained slightly heavier subsoil. Internal drainage is slow, owing to the flat relief and a siltpan layer, which in some places is developed at 3 feet. The substrata consist of gray and yellow friable silty clay loam, and below 6 feet are mottled silts and clays that are nearly neutral in reaction. The soil occurs on flat terrace positions.

A total of 1,536 acres is mapped, in scattered areas throughout the general-farming area. The largest areas occur in the southwestern part of the county. The land is from 1 to 6 feet or more above the adjoining bottom land.

A larger proportion of Peoga silt loam than of Clermont silt loam is utilized. Only 17 percent of it is timbered. Corn and wheat, the principal crops, occupy 19 and 11 percent, respectively, of the soil. Red clover, timothy, and mixed hay are grown on 12 percent of the land.

HILL-FARMING AND FORESTRY AREA

The hill-farming and forestry area (2B) includes the rolling Knobstone lands on the western border of the county. Farming operations are performed on the long narrow ridge tops and on the alluvial bottom soils. The hillsides are too steep and stony to be farmed and are consequently almost entirely wooded.

WELL-DRAINED SOILS

The rolling relief and the completeness and thoroughness of dissection by streams provide good natural drainage for all the soils of area 2B. About 25 percent of the ridges are planted to corn, wheat, and hay, and the rest is in low-grade pasture or idle land and timberland. The soils in this group are Zanesville silt loam; Zanesville-Wellston silt loams, eroded phases; Zanesville-Wellston silt loams, gullied phases; Wellston silt loam; Wellston silt loam, slope phase; Tilsit silt loam; Muskingum stony silt loam; and Muskingum gravelly silt loam, colluvial phase.

The Zanesville and Muskingum are the principal soils. The wider ridge tops are more widely used than the narrow ones because of less susceptibility to erosion and the greater efficiency of field layout. Most of the timber was cleared from the ridges during the period of rapid expansion in farming. Now the trend is to abandon these soils for farming. Broomsedge and poverty grass do not furnish an adequate ground cover and does not protect the land from erosion. The land is gradually being covered with briers, sumac, persimmon, oak, and hickory sprouts, which will eventually result in a natural regeneration of the forest cover.

Zanesville silt loam.—This soil occurs on the rounded ridge tops throughout the rolling sandstone and shale upland, where there is more than 3 or 3½ feet of soil overlying the rock. A total area of 4,032 acres is mapped. The relief ranges from nearly level to 15-percent slope, and a difference of 150 feet in elevation is commonly found between the ridge tops and the nearby valley floor.

The 8- to 12-inch surface soil is slightly brownish-gray mellow smooth silt loam, which is pale brown when moist. It gives way abruptly to a subsoil of slightly light-brown friable silty clay loam. At a depth of 28 to 32 inches gray and yellow mottlings indicate that internal drainage is somewhat retarded by the moderately compact siltpan layer below, which extends to a depth of 32 to 40 inches. The underlying subsoil becomes more friable and gritty with depth. The parent material consists of weathered interbedded sandstone, siltstone, and shale, which is thoroughly disintegrated down to the contact between soil and rock.

Plate 2 is a vertical aerial view of a typical section of the sandstone upland along the Brown County line in the northwestern part of the county.

Zanesville silt loam is subject to severe sheet erosion where tilled crops, such as corn, are grown on the steeper slopes, and consequently the depth of the surface soil is quite variable. Crops are grown on only 18 percent of the soil. Yields of corn average about 25 bushels an acre, and of wheat about 18 bushels. Some farmers follow a wheat and meadow rotation on the ridges and grow their corn on the bottom land. Corn and soybeans for hay are grown on the wider ridges. Clover can be grown only when the soil has been limed. Timothy is the most common meadow crop. About 45 percent of this land consists of idle land or low-grade pasture.

Small acreages of special crops, such as tobacco, tomatoes, green beans, and sweet corn and apples, are grown. Tomatoes are generally fertilized with manure and 300 to 400 pounds of 2–12–6 or 4–12–8 fertilizer. They yield about 6 tons an acre, and tobacco about 800 pounds. Commercial orcharding has not been very successful because of the low fertility, low moisture-holding capacity, and erodibility of the soil.

Zanesville-Wellston silt loams, eroded phases.—A total area of 128 acres of these phases, which have less than 6 inches of surface soil remaining, is mapped. This condition prevails generally on the steeper cultivated land adjacent to the wooded slopes. The slopes average about 15 percent gradient. The surface soil in many places is completely removed and the yellowish-brown subsoil exposed. A few shallow gullies occur in this soil. The subsoil is underlain by sandstone at depths of 2½ to 4 feet. On the areas that have rock at shallow depths the siltpan layer is absent.

Probably 6 percent of these phases are being cropped. Wheat and meadow are the principal crops grown. Yields are low because of the poor physical condition and the low fertility of the soil. Most of these phases have a moderate cover of broomsedge, poverty grass, and occasionally some common lespedeza. About 14 percent has little cover of any kind and the eroded subsoil is exposed. About 68 percent is covered with briers, brush, and sprouts. A grass cover prevents erosion in many places. Lespedeza and black locust are the

Aerial photograph of the front of the sandstone upland along the Bartholomew-Brown County line, $2\frac{3}{4}$ miles southwest of Kansas. *A*, Steep wooded slope surrounding high sandstone ridge that projects into the adjacent low-lying Illinoian drift plain; *B*, rectangular fields of level area of Illinoian glacial till (note contrast with *C*); *C*, irregular ridge-top fields on a sandstone ridge; *D*, severe erosion on rolling former field (note how erosion is confined to cleared areas); *E*, cultivated field; *F*, turn in road; *G*, farmstead.

ıost desirable plants that can be grown on this land in its present condition, because they retard erosion and also increase the nitrogen and organic-matter content. This soil is better adapted to forestry than to farming.

Zanesville-Wellston silt loams, gullied phases.—The soil of these phases has been severely sheet-eroded and dissected by numerous gullies a foot or more deep. Portions of the brownish-gray surface soil remain between gullies in many places, particularly in pastures. The brown subsoil is exposed in badly sheet-eroded areas and gullies. The depth to rock ranges from 2½ to 4 feet. This land is unsuited for ınd organic-matter content. These soils are better adapted to forestry than to farming.

Wellston silt loam.—This soil occurs on knife-edge ridge tops derived from sandstone, which lies within 2½ to 3 feet of the surface. It has a rolling relief, the slope ranging up to 15 percent. A total area of 384 acres is mapped.

The 8- to 10-inch surface soil is a weak-brown to pale-brown smooth silt loam. It is underlain by a slightly light-brown friable silty clay loam subsoil, which in a few places is slightly mottled at the contact with the sandstone and shale. No siltpan layer is present. Shale and sandstone fragments occur within 2 feet of the surface.

Nearly one-half of the sharp ridges have been cleared of timber and cropped for some time, but the small irregular fields, the severity of ·osion, and the rapid depletion of fertility have largely caused the l to revert to low-grade pasture land and woodland. A small proportion is farmed to meadow, wheat, and corn. As the soil is strongly acid, clover and most other legumes cannot be grown without the application of about 2 tons of lime to the acre.

Wellston silt loam, slope phase.—This soil consists of moderately steep upper slopes of this area (2B). The slopes of 15 to 25 percent or more are used largely for forest. The land is too steep for general-farming operations. A small proportion that was cleared is now in low-grade pasture land. Owing to erosion and lack of fertility, only 10 percent of the soil of this phase is now used for crops, the rest having reverted to broomsedge pasture.

The soil of this phase is similar to the normal Wellston silt loam. The soil is 2 to 4 feet thick, and its greatest depth occurs on the upper part of the steeper slopes and on gentler slopes. About one-eighth of it would have been mapped as Zanesville silt loam, slope phase, had the area been larger. A total area of 1,024 acres is mapped.

Tilsit silt loam.—This soil occurs on level parts of the broader ridge tops, associated with Zanesville silt loam. A total area of 128 acres is mapped. There are several areas a few miles west and southwest of Precinct School and a few miles north and northeast of South Bethany.

The surface soil is brownish-gray smooth mellow silt loam 10 to 12 inches thick. It is underlain by yellow friable silty clay loam, which becomes slightly heavier and more compact with depth. At a depth of 20 inches the soil is mottled gray and yellow, owing to impeded drainage caused by the underlying siltpan layer at 3 feet. Below 42 inches this material becomes more friable and less mottled, grading into shale and sandstone parent material at 4 to 7 feet. The entire

profile is strongly acid. Surface drainage is slow, and internal drainage is only fairly well established.

About 3½ miles north of South Bethany a small area of soil with imperfect drainage, like Johnsburg silt loam, was included with the Tilsit silt loam. This soil has a light brownish-gray surface soil and a mottled gray and yellow subsoil from a depth of 10 to 18 inches. In other respects it is similar to Tilsit silt loam.

Tilsit silt loam is more extensively cropped than the other ridge-top soils because it is not subject to severe sheet erosion. Wheat, corn, and timothy are the principal crops. Yields are similar to those on Zanesville silt loam.

A total area of about 50 acres of soil derived from very tough waxy clay shales occurs ½ mile north of Mount Healthy Church, and a few small areas of this shale outcrop on the sides of hills throughout the sandstone region. The 8-inch surface soil consists of pale-brown heavy silt loam, underlain by a tough waxy yellow silty clay subsoil, which in some places is slightly mottled with gray and orange. It grades into tough, heavy, variegated, brownish, neutral clay shale at about 3 feet. The soil is strongly acid above the parent material. The land is gently rolling. The crops grown and the yields are similar to those on typical Tilsit silt loam.

Muskingum stony silt loam.—This is the most extensive soil in the hill-farming and forestry area. A total area of 7,040 acres is mapped. It occurs on steep slopes of 25 to 40 percent gradient. In the forested areas it has a dusky-brown, highly organic, nearly neutral surface soil 1 to 3 inches deep. The subsurface layer is light grayish-yellow silt loam, which in most places contains a small quantity of very fine sand. The subsoil consists of yellowish-brown heavy silt loam or light silty clay loam, underlain by hard resistant sandstone rock and interbedded shale at depths of 15 to 20 inches. Below the immediate surface the soil is strongly acid in reaction. Hard resistant brownish-gray sandstone fragments 4 to 10 inches in diameter are found throughout the soil profile.

Originally this soil was completely covered by timber, but it has all been cut over several times since the county was settled. About 84 percent of it has a second-growth forest cover. The most common species of trees are black oak, pignut, butternut, and shellbark hickory, with a few sugar maples, ash, and elm on the moist lower slopes. Tree growth is rather slow, and nearly all the trees in the forests are less than 10 inches in diameter 4 feet from the ground. Trees are usually cut as soon as they reach railroad-tie size.

On the less stony and less steep upper slopes a small acreage of crops may be grown, but most of the cleared land consists of broomsedge pasture.

Muskingum gravelly silt loam, colluvial phase.—The areas of this phase have no definite soil profile development and are quite variable in composition. They are formed from sheet erosion or an accumulation of clay, silt, and shale. The 6- to 15-inch surface soil is pale brown and ranges from light silty clay loam to gravelly loam. Variable quantities of gravel occur through the profile. The gravel consists of angular fragments of sandstone and shale rather than of rounded pebbles. The subsoil is dull brown and in some places is

blotched with orange-colored iron stains and some gray mottling. The soil is strongly acid. A total area of 128 acres is mapped. Many of these areas have been cleared and cultivated in the past. The cover on a large part of this phase consists of low-grade pasture, such as broomsedge and poverty grass. Corn, wheat, and soybeans are grown to a limited extent.

ACID ALLUVIAL SOILS OF THE HILL-FARMING AND GENERAL-FARMING AREAS

The overflow bottom soils of the hill-farming and general-farming areas are medium to strongly acid in reaction and range from rapidly to very poorly drained. They are light-colored and relatively low in organic-matter content and range from medium to low in productivity. They occur in the valleys of small tributary streams, which have their steepest gradients at their source in the sandstone hills. Consequently, drainage conditions of the soil are best established in the narrow upper stream courses, and they become progessively poorer as the gradient declines and the valleys widen as they traverse the Illinoian till plain. The acid alluvial soils of these areas are classified as follows: Well-drained alluvial soils—Pope gravelly loam, Pope silt loam, and Philo silt loam; imperfectly drained—Stendal silt loam; and very slowly drained—Atkins silt loam.

WELL-DRAINED ALLUVIAL SOILS

Pope gravelly loam.—This soil occurs in the upper stream courses of the more or less V-shaped valleys of the sandstone area. The 10-inch surface soil is weak brown and is dominantly a gravelly loam. The content of gravel or flat brown sandstone ranges from 10 to 60 percent in various parts of the soil. At a depth of 15 to 20 inches the subsoil becomes more gravelly. It is pale brown and contains less organic matter than the surface soil. The content of available plant nutrients is low, and it has a very low water-holding capacity. A total area of 320 acres is mapped.

About 4 percent of the soil is planted to corn and wheat. Corn acreage is limited because the droughty soil generally produces low yields. Much of the land has reverted to low-grade pasture and is gradually reverting to forest. About 49 percent of the land has never been cleared of timber.

Pope silt loam.—This soil occurs in the narrow, well-drained bottoms of the sandstone area. The surface soil is weak-brown to pale-brown mellow gritty silt loam, which grades at a depth of 10 to 15 inches into a brownish-yellow gritty silt loam containing considerable gravel in some places at a depth of 30 inches or more. A total area of 1,664 acres is mapped. This soil is strongly acid nearly everywhere, but in a few places it is nearly neutral throughout the 3-foot section.

Where the soil has been limed, a variety of crops are grown, including corn, wheat, clover, and alfalfa and such special crops as tomatoes, green beans, and tobacco. Corn, grown on 15 percent of the soil, is the principal crop and yields are 25 to 30 bushels an acre. Tomatoes yield about 6 tons where the crop has been manured or fertilized. In the smaller bottoms the principal uses of the land are

for broomsedge pasture and timber. About 31 percent of the soil is timbered, and 32 percent consists of low-grade pasture and idle land.

Philo silt loam.—This is a fairly well-drained soil that occurs as a border along the larger creeks and as a connecting link in minor streams between the well-drained Pope soils of the small bottoms and the imperfectly drained Stendal soils of the wider bottoms. A total area of 4,288 acres is mapped.

Philo silt loam has a smooth, mellow, pale-brown surface soil, which grades into a slightly brownish gray subsoil containing less organic matter. At average depth of 20 inches the silty subsoil is mottled gray and yellow. No definite heavier layers occur in the profile, although the subsoil as a whole is usually slightly heavier than the surface soil. In most places Philo silt loam is strongly acid, but in a few areas the soil is nearly neutral in reaction.

Crops do not suffer from poor drainage on this soil, and there is adequate moisture in most years to produce fairly large yields of corn. In some places where the soil has been limed a rotation of corn, wheat, and clover is followed. Because of the acid soil conditions and the lack of reserves of plant nutrients, a rotation in which legumes are grown has been found necessary to maintain crop yields. The average yield of corn on unlimed land in which legumes are not grown is about 30 to 35 bushels an acre, and on well-managed areas 50 bushels. Corn is the dominant crop, although a variety of other crops are grown. Wheat yields average about 15 bushels an acre. Both medium and mammoth clover are grown, the latter being widely used because it produces a greater quantity of organic matter. On unlimed land soybeans and timothy are the principal crops grown for hay. Small acreages of special cash crops, such as tobacco, tomatoes, cabbage, and sweet corn, are commonly grown. This is the most productive soil as well as one of the most responsive soils of the hill- and general-farming areas.

IMPERFECTLY DRAINED ALLUVIAL SOILS

Stendal silt loam.—This is the dominant soil of the overflow bottoms throughout the general-farming area. Crop yields are reduced considerably by the poor drainage of the soil. A total area of 10,688 acres is mapped. The largest areas occur in the East Fork White River Valley.

Stendal silt loam has a light brownish-gray to pale-brown smooth silt loam surface soil, which becomes quite gray when dry. It puddles and bakes, forming rather hard clods when dry. Below plow depth the subsoil is a mottled gray and yellow or brown silty clay loam. Rusty brown iron and manganese concretions are numerous on the surface, and blotches and stains are usually found throughout the profile.

A few areas of Stendal silty clay loam have been included with this soil. They differ principally in the heavy surface soil and the tougher, more waxy subsoil. The entire soil profile is strongly acid.

More than three-fourths of the Stendal silt loam has been cleared of timber and brought under cultivation. Owing to the poor drainage conditions, the quantity of crops grown and the yields depend largely on weather conditions and rainfall. In normal seasons good yields are

obtained. Because of the low position, artificial drainage is rather difficult to establish. Plowing in narrow lands with numerous dead furrows is the more common practice. Some areas are tiled and ditched. The principal crops are corn, wheat, and hay. Corn yields 25 to 30 bushels an acre. Corn and soybeans are the best adapted crops, because planting can be delayed until the soil dries. Wheat is grown on the higher areas of this land. The most poorly drained areas of the soil have been kept in timber. The most common species of trees are pin oak, swamp white oak, ash, elm, red maple, beech, and redgum.

VERY SLOWLY DRAINED ALLUVIAL SOILS

Atkins silt loam.—This type includes the most poorly drained soils of the bottoms. It occurs on low areas that dry very slowly. The soil is better adapted to forestry than to agriculture. Large areas occur in White Creek Valley and along other streams in the southwestern part of the county. A total area of 3,328 acres is mapped.

Atkins silt loam has a light-gray surface soil with numerous turkey-shot concretions scattered over and through it. The silty clay loam subsoil below a depth of 8 to 10 inches is bluish gray to gray with numerous rusty-iron blotches and stains.

Less than 15 percent of this soil is cropped, and in wet seasons scarcely any crops are grown, as the land is slow to dry out. Corn is the principal crop. Broomsedge pasture and timber are the principal uses for this soil, and 63 percent of it is timbered.

Included with Atkins silt loam are about 200 acres where the texture of the surface soil is silty clay loam. This heavier textured soil occupies the lowest parts of the bottom land, and most of it occurs in White Creek Valley.

Pits and quarries.—Pits and quarries have been opened in many places for the removal of gravel or limestone. The largest of these are gravel pits in the terraces along the Driftwood River in the vicinity of Columbus, but there are several smaller one in other parts of the county. Limestone is quarried in a few places in the eastern part of the county.

LAND USES

The relation between soil type and land use, particularly for crops to which the soil is well suited, has always been one of particular interest and study in the soil survey. For the first time such a study has been made in great detail for Bartholomew County. With the use of aerial photographs, a map of all the crops was made at the same time that the soils were mapped. All of the major uses, such as clean-tilled and small-grain crops, special crops, hay, pasture, forest, and nonagricultural uses, were separated. Each individual crop was mapped where fields were an acre or more in size. A comparison of the land-use map with the soil map showed how the farmers were using each soil in the county. Some of the results are shown in table 5 and in references to soil type and land use elsewhere in this report.

TABLE 5.—*Approximate percentage of certain soils in Bartholomew County, Ind., occupied by vario*

Soil type	Corn	Oats	Wheat	Soybeans	Other crops and unidentified cropland	Special crops	Red clover	Hay, mixed	Alfalfa and sweetclover
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Brookston silty clay loam	37		25	3	2	4	10	7	1
Westland silty clay loam	34	1	29	3	3	7	6	5	3
Abington silty clay loam	23	1	37	3	4	5		7	5
Lyles loam	33		26	5	5	7	5	9	2
Genesee silt loam	45		21	2	1	4	1	1	3
Genesee silty clay loam	40		35	1	2	4	1		5
Genesee silt loam, high-bottom phase	25		50	2	4	4		1	8
Ross silty clay loam	47	2	33	4	2	3	1	1	3
Genesee loam	39		13	1	2	1	1	3	5
Genesee loam, high-bottom phase	35		27	10	4	6		2	6
Ross loam	65		9		4	9			
Miami silt loam	28	2	19	2	3	6	8	5	1
Russell silt loam, shallow phase	26	1	21	1	5	4	6	6	1
Russell silt loam	25		21	3	3	4	9	8	
Eel silty clay loam	42		25	2	1	2	1	3	3
Russell loam	22	1	28	1	3	3	3	12	3
Fox silt loam	28	1	33	6		5	6	4	4
Martinsville silt loam	30		36	2	2	4	3	4	2
Nineveh loam	25		26	4	2	5	2	1	5
Eel silt loam	25	1	16	2	2	4	5	5	1
Martinsville loam	32	2	30	6	4	6	3	4	2
Zipp silty clay loam	32			8	1	23	12		4
Fox loam	26	1	32	6	2	5	2	3	5
Crosby silt loam	33	2	23	1	3	4	8	7	1
Fincastle silt loam, shallow phase	29		26	4	3	4	10	7	1
Fincastle silt loam	30		24	3	3	4	11	7	1
Whitaker loam	35	1	24	6	3	4	5	5	2
Whitaker silt loam	37		33	2	2	4	5	5	1
Fincastle loam	30		22	3	3	9	7	7	
Eel loam	23		18		1	3	1		1
Fox sandy loam	29	1	22	5	1	2	1	1	5
Martinsville fine sandy loam	24		39	10	2	4	3	2	3
Genesee fine sandy loam	50		12	1					1
Milton silt loam	23	2	10		4	5	6	6	1
Parke silt loam					4		10	1	
Shoals silty clay loam	37		27	1		7	5	3	2
Gibson silt loam	14		10	1	4	2	2	2	
Haubstadt silt loam	15		12	1	1	2	4	7	

Cincinnati silt loam	10		4		5	2		2	
Princeton fine sandy loam	25		21	5	4	8	6	6	3
Elkinsville silt loam	9		9	1		1	3	1	3
Cincinnati silt loam, shallow phase	2		1	1	6	7	2		
Gibson silt loam, slope phase	11		8	1	2	1	1	2	
Nineveh gravelly loam	37	2	26		6	1	4	5	5
Philo silt loam	16		6	1	3	1	2	6	
Ayrshire loam	24	1	29	4	6	6	7	8	1
Princeton loamy fine sand	39		13			1	12	19	
Dubois silt loam	22		19	3	4	3	4	6	
Avonburg silt loam	17		11	2	5	3	2	4	
Pope silt loam	15	1	5	1	6	1	1	3	
Clermont silt loam	14		9	2	4	1	2	3	
Peoga silt loam	19		11	1	1	3	4	8	
Delmar silt loam	29		17	3	2	2	13	5	2
Zanesville silt loam	5		3		7	2	1		
Muskingum gravelly silt loam, colluvial phase	6		3			20		1	
Stendal silt loam	12		9	1	4		3	3	
Carlisle muck	4		9			9			
Fox gravelly loam	34		23	2	3	2	1	3	4
Pope gravelly loam	2		2		3	1			
Atkins silt loam	7		2		2		1	1	
Wellston silt loam	8		11		3			1	
Miami silt loam, slope phase	32		12	2		16			10
Miami silt loam, eroded phase									
Russell silt loam, steep phase	13		13	1	2	2	3	5	1
Princeton fine sandy loam, slope phase	5		21	2	2	3	2	1	3
Russell silt loam, eroded phase	9		61			13		17	
Rugby silty clay loam					1	3		3	2
Cincinnati silt loam, eroded phase	12		8			2	5	4	
Zanesville-Wellston silt loams, eroded phases			2			4			
Cincinnati silt loam, steep phase	5		2	3		1	1	1	
Wellston silt loam, slope phase	3		1		2	1		4	
Cincinnati silt loam, gullied phase	5		2		3	1	1		
Zanesville-Wellston silt loams, gullied phases	4		1		1	1	1		
Muskingum stony silt loam	1				2				

This study was made of the entire county without regard for farm boundaries. Farmers over a long period of time by a trial-and-error process have adjusted their systems of farming to the character of the soil and to economic conditions, although continuous readjustment must be made. Some of the more important soil factors that influence the use of soils are the inherent productivity, the acidity, the lay of the land, the susceptibility to soil erosion, the drainage conditions, the moisture-holding capacity, and the content of organic matter and nitrogen.

Nonagricultural uses account for only a small proportion of the total area of the county. Even in such uses some soil characteristics, such as drainage and elevation may be considered. Approximately 2 percent of the county has been used for farmsteads. On the nearly level till plain in the eastern part farmers generally select slightly elevated knolls, which provide better than average drainage conditions for the farmsteads.

The suitability of different soil conditions to different crops is generally recognized and is reflected to a considerable extent in the systems of farming and the use of the land. The dominant soil usually determines the use of a field, consequently the more productive soils occurring in small irregular areas cannot be used in the most efficient manner.

The forested land of the county comprises 14.6 percent of the total area. Nearly all of this land is in small tracts that are parts of farms. Little timber of commercial value remains, and few farmers are following good forestry practices to increase financial returns. In the more fertile eastern part of the county bluegrass is well adapted, and consequently most of the woods are pastured. The land is not reverting to forest, therefore it is used more and more for pasture. In the western part of the county nearly one-third of the land is in forest, owing to the low level of fertility and the strong acidity of the soils. Kentucky bluegrass is not adapted to this land. Little livestock is kept on the land, and reforestation is therefore not hindered by pasturing. Timber is used as a source of farm income, and trees are usually cut when they reach the size of railroad ties. The most extensive timbered areas occur in the Knobstone area along the Brown County line. Here tree growth is slow but the trees are valuable commercially. The highest proportion of timber occurs on soils that are too steep to farm, that have inadequate drainage or that have a low level of agricultural productivity.

In mapping the use of land, pastures were divided into (1) first-grade pastures, consisting of permanent Kentucky bluegrass; and (2) second-grade pastures with low feed value, consisting largely of broomsedge, poverty grass, and relatively little or no bluegrass. Kentucky bluegrass requires a relatively fertile soil, consequently most of the good pastures are in the eastern and northern parts of the county, where about 8 percent of the land is used for first-grade pasture and less than 2 percent for low-grade or broomsedge pasture. Broomsedge grows largely on the steep, eroded, or less fertile soils.

In the western part of the county approximately 25 percent of the land was cleared for second-grade pasture land and the areas used for first-grade pasture were insignificant. This second-grade pasture land occurs on soils that could be used as cropland. This land is grazed

Beef cattle being fattened on mature corn standing in a field of Crosby, Brookston, and Miami

A.—Effects of phosphate, potash, and nitrogen on yields of wheat on Jennings County experiment field on Clermont silt loam. The crop rotation was corn, wheat, and mixed hay. Average acre yields: *a*, No fertilizer, 9.7 bushels; *b*, fertilized with 300 pounds of 0–12–0, 24.0 bushels; *c*, fertilized with 300 pounds of 0–12–8, 28.5 bushels; *d*, fertilized with 300 pounds of 2–12–8, 32.7 bushels.

B.—Effects of lime and fertilizer on yields of corn on Jennings County experiment field on Clermont silt loam. The crop rotation is corn, wheat, and mixed hay. The land was limed at the rate of 3 tons of ground limestone to the acre in 1920 and 2 tons in 1935. Fertilizer was applied at the rate of 100 pounds of 2–12–8 in the row for corn and 300 pounds of 2–12–8 for wheat. Average acre yields: *a*, Untreated, 21.1 bushels; *b*, fertilizer alone, 41.7 bushels; *c*, fertilizer and lime, 82.8 bushels.

very little, and much of it has been in plowable pasture land for 10 years or more. Idle land, consisting of almost bare ground with some growth of annual weeds, covers about 12 percent of the western part of the county. After 2 years or more of idleness, perennial grasses, sedges, and weeds cover this land, converting it into second-grade pastures. Sprouts and seedlings of trees encroach on the ungrazed pasture land and eventually convert it into forest land.

The proportion of land put to more intensive uses, such as special crops and general farm crops, is directly related to the inherent fertility of the soil and the slope of the land. The rolling Knobstone area along the western border of the county has approximately 7 percent of the land in crops. The area west of the East Fork White River has approximately 30 percent in crops. In the rest of the county an average of 80 percent of all the land is cropped.

Corn is the major crop and occupies nearly 25 percent of the area of the county. It is grown on nearly all soils, but it is most extensive on the rich overflow soils of the East Fork White River Valley and the dark-colored formerly swampy soils of the uplands and terraces. These soils are especially well adapted to corn because of an abundant supply of moisture and available plant nutrients (pl. 3).

Wheat is grown on nearly 19 percent of the county's area. It requires a well-drained soil of relatively high fertility. Most of the wheat is grown on Genesee silt loam, high-bottom phase; Martinsville fine sandy loam; Martinsville silt loam; and Fox loam. Soybeans are most extensively grown on the Fox soils and Martinsville fine sandy loam. These soils have low moisture-holding capacity, and soybeans are well suited to withstand drought.

Leguminous hay crops are sensitive to acidity and phosphorus deficiency, consequently they are grown most extensively in the eastern part of the county. A large proportion of red clover is grown on several soils in the eastern half of the county, but little is grown west of the East Fork White River Valley. Alfalfa is less tolerant of acidity than red clover, and in addition it requires a well-drained soil. The highest proportion of this crop is grown on the Fox and Nineveh soils.

PRODUCTIVITY RATINGS

In table 6 the soils of Bartholomew County are listed alphabetically and crop-productivity indexes or ratings are assigned for each of the important crops according to two distinct levels of farm management.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard index represents what might be considered the approximate average yield obtained on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 6 is given at the head of each respective column. Soils given amendments, such as lime and commercial fertilizers, or special practices, such as irrigation, and unusually productive soils of small extent, may have productivity indexes of more than 100 for some crops.

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TABLE 6.—*Productivity ratings of soils in Bartholomew County, I*

Soil	Crop productivity index [1] for—																			
	Corn (100= 50 bu.)		Wheat (100= 25 bu.)		Oats (100= 50 bu.)		Soybeans (100= 25 bu.)		Mixed hay (100= 2 tons)		Red clover (100= 2 tons)		Alfalfa (100= 4 tons)		Potatoes (100= 200 bu.)		Vegetables [2]		Apples [2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Abington silty clay loam (drained).	90	110	80	100	80	90	90	100	110	125	70	80	60	70	50	80	70	90		
Abington silty clay loam (undrained).	20				20				50											
Atkins silt loam (drained)	40	70	30	40	20	30	40	50	75	90	20	30						20		
Atkins silt loam (undrained)	20						30		40											
Avonburg silt loam (drained)	40	90	50	80	50	60	60	80	50	90		50			20	50	20	40		
Avonburg silt loam (undrained).	30		30		30		40		25											
Ayrshire loam (drained)	60	80	60	80	50	60	60	70	75	90	30	80	10	30	25	50	40	60		
Ayrshire loam (undrained)	30		40		20		50		60											
Bartle silt loam (drained)	50	90	50	70	50	60	60	80	50	90	10	50		15	30	60	20	40		
Bartle silt loam (undrained)	40		30		30		40		25											
Brookston silty clay loam (drained).	100	110	70	100	80	90	90	100	110	125	90	100	70	90	50	80	70	100		
Brookston silty clay loam (undrained).	40						50		100											
Carlisle muck (drained)	40	100					30	80	50	125					30	90	30	[3]100		
Carlisle muck (undrained)																				

Cincinnati silt loam	40	70	40	80	40	70	50	80	30			60		30	20	60	30	50	50	60
Cincinnati silt loam, eroded phase.	10	50	10	50	--	--	--	--	20	40	--	--	--	--	--	--	--	--	--	--
Cincinnati silt loam, gullied phase.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cincinnati silt loam, shallow phase.	50	70	40	70	50	70	40	70	40	75	--	60	--	30	20	50	30	50	40	50
Cincinnati silt loam, steep phase.	--	--	--	--	--	--	--	--	25	40	--	--	--	--	--	--	--	--	--	30
Clermont silt loam (drained)	50	100	40	80	50	60	40	80	50	90	--	60	--	--	10	40	20	30	--	--
Clermont silt loam (undrained).	40	--	20	40	20	--	30	--	25	--	--	--	--	--	--	--	--	--	--	--
Cope silty clay loam (drained).	90	100	70	90	60	80	80	90	110	125	80	100	70	90	50	80	70	100	--	--
Cope silty clay loam (undrained).	50	--	--	--	30	--	50	--	100	--	70	--	--	--	25	--	30	--	--	--
Crosby silt loam (drained)	60	90	60	90	50	70	60	70	70	100	50	90	40	80	30	60	40	60	20	30
Crosby silt loam (undrained)	40	--	40	--	40	--	50	--	50	--	40	--	--	--	--	--	20	--	--	--
Delmar silt loam (drained)	40	70	50	70	40	50	50	60	60	80	30	80	--	50	20	40	30	50	10	20
Delmar silt loam (undrained).	30	--	20	--	20	--	40	--	40	--	--	--	--	--	--	--	10	--	--	--
Dubois silt loam (drained)	50	90	50	80	50	60	60	80	50	90	10	50	--	--	20	40	20	40	--	--
Dubois silt loam (undrained).	40	--	30	--	30	--	40	--	25	--	--	--	--	--	--	--	--	--	--	--
Eel loam (drained and protected by levee).	100	100	60	70	60	70	90	100	125	--	80	90	50	75	50	80	60	80	--	--
Eel loam (undrained and unprotected by levee).	90	--	--	--	50	--	60	--	100	--	--	--	--	--	--	--	30	--	--	--
Eel silt loam (drained and protected by levee).	120	120	60	70	60	70	90	100	100	125	80	90	50	75	50	75	60	80	--	--
Eel silt loam (undrained and unprotected by levee).	100	--	--	--	--	--	--	--	80	--	--	--	--	--	--	--	--	--	--	--
Eel silty clay loam (drained and protected by levee).	120	120	60	70	60	70	90	100	125	125	80	90	50	75	40	70	60	80	--	--

See footnotes at end of table.

TABLE 6.—*Productivity ratings of soils in Bartholomew County, Ind.*—C

Soil	Crop productivity index [1] for—																			
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables [2]		Apples [2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Eel silty clay loam (undrained and unprotected by levee).	100						80		100											
Elkinsville silt loam	60	80	50	80	50	70	30	80	40	75	10	60		60	40	60	30	50	40	50
Fincastle loam (drained)	60	90	60	80	50	60	50	70	100	125	30	90	30	80	25	50	40	60	20	30
Fincastle loam (undrained)	40		40		40		40		75		40									
Fincastle silt loam (drained)	60	90	50	80	50	70	60	80	100	125	30	80	30	80	25	50	20	60	20	30
Fincastle silt loam (undrained).	40		40		40		50		75		25									
Fincastle silt loam, shallow phase (drained).	60	90	60	80	60	70	60	70	100	125	30	75	20	80	25	50	20	60	20	30
Fincastle silt loam, shallow phase (undrained).	40		40		40		50		75		50		15		25		10			
Fox gravelly loam	10	30	40	50	10	20	20	40	40	60	20	40	30	50					30	40
Fox loam	60	80	90	110	50	70	60	80	75	100	30	50	40	75	40	60	50	80	40	50
Fox sandy loam	40	70	60	90	40	50	60	70	60	90	20	40	40	60	20	50	40	50	40	50
Fox silt loam	70	90	90	110	50	70	60	80	90	110	30	60	40	80	30	60	50	80	40	50
Genesee fine sandy loam (protected by levee).	70	80	70	80	50	60	80	90	50	75	30	60	50	75	40	75	30	50	20	30
Genesee fine sandy loam (unprotected by levee).	70						60		50	75	20	40	20	50	20	50	20	50	20	30
Genesee loam (protected by levee).	100	110	60	80	60	70	90	100	100		80	100	70	80	40	80	50	100	20	30
Genesee loam (unprotected by levee).	90						80		80		50		30		30		50		20	
Genesee loam, high-bottom phase.	80	100	70	80	70	80	80	90	100	110	80	90	80	90	40	80	50	90	20	30

Genesee silt loam (protected by levee).	100	110	70	90	90		90	100	125		100		70	90	40	80	50	100	20	30
Genesee silt loam (unprotected by levee).	100				60		80		110		60		30		30		50		20	
Genesee silt loam, high-bottom phase.	100	110	70	100	80		80	90	110	125	80	100	80	90	40	80	50	100	20	30
Genesee silty clay loam (protected by levee).	100	110	70	90	90		90	100	125		100		60	80	40	80	50	100	20	30
Genesee silty clay loam (unprotected by levee).	100				30		80		110		50				40		60		20	
Gibson silt loam	50	80	50	80	50	70	50	80	40	75	10	60		60	25	60	20	50	40	50
Gibson silt loam, slope phase.	40	70	40	70	40	70	40	70	40	75	10	60		60	25	65	20	50	50	60
Haubstadt silt loam	50	80	50	80	50	70	50	80	40	75	10	60		60	50	75	30	50	30	40
Haubstadt silt loam, slope phase.									10	30									10	30
Homer loam (drained)	60	80	70	80	50	70	60	80	75	100	50	80	40	70	20	50	30	50		
Homer loam (undrained)	40		50		40		50		60		30				25		20			
Lyles loam (drained)	90	100	70	90	80		80	90	110	125	70	80	50	60	50	70	60	80		
Lyles loam (undrained)	50				40		50		75		40									
Lyles silty clay loam (drained).	90	110	70	90	90		90	100	110	125	70	80	40	50	50	70	60	80		
Lyles silty clay loam (undrained).	50				40		50		75		30									
Martinsville fine sandy loam	50	70	40	60	40	50	60	70	60	90	30	60	30	60	40	60	30	50	40	50
Martinsville loam	50	90	60	90	50	70	70	80	60	110	50	80	40	80	30	60	30	60	40	50
Martinsville silt loam	60	90	60	90	50	70	70	80	60	110	60	90	40	80	30	60	30	70	40	50
Miami silt loam	60	90	50	100	50	80	50	90	60	110	60	90	40	80	30	60	30	70	60	70
Miami silt loam, eroded phase.	10	30	20	50	10	40	20	50	20	50	10	50	10	50						
Miami silt loam, slope phase	10	30	20	50	10	40	20	50	30	60	20	60	10	60			40		10	40
Milton silt loam	50	70	50	80	50	60	50	80	75	100	50	80	20	50	30	60	30	50	40	60
Muskingum gravelly silt loam, colluvial phase.	40	60	40	70	40	60	30	60	50	75	10	50			25	50	20	40		10
Muskingum stony silt loam																				

See footnotes at end of table.

TABLE 6.– *Productivity ratings of soils in Bartholomew County, Ind.*—

Soil	Crop productivity index [1] for—																			
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables [2]		Apples [2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Nineveh gravelly loam	40	60	50	80	40	50	50	70	60	80	20	50	30	70	30	60	30	50	20	30
Nineveh loam	60	80	90	110	50	70	60	80	60	90	30	70	40	80	30	60	50	80	40	50
Parke silt loam	50	70	50	80	50	70	50	70	40	75	10	60	—	50	25	60	40	50	60	70
Pekin silt loam	50	80	50	80	50	70	50	70	40	75	10	60	—	50	25	60	30	50	30	40
Peoga silt loam (drained)	50	100	40	70	50	60	60	90	50	90	10	70	—	40	25	50	20	30	—	—
Peoga silt loam (undrained)	40	—	20	—	20	—	40	—	25	—	—	—	—	—	—	—	—	—	—	—
Philo silt loam (drained)	60	90	40	60	40	60	60	80	90	100	10	60	—	—	25	60	40	60	—	—
Philo silt loam (undrained)	50	—	—	—	20	—	40	—	60	—	—	—	—	—	—	—	—	—	—	—
Pope gravelly loam	40	70	30	50	40	50	40	50	50	60	—	30	—	—	25	50	30	50	—	—
Pope silt loam	50	80	50	80	40	60	50	20	60	90	—	50	—	—	25	60	40	60	—	—
Princeton fine sandy loam	40	50	40	60	20	40	40	60	25	50	10	30	30	60	30	60	50	[6] 100	50	[7] 70
Princeton fine sandy loam, slope phase.	10	20	10	20	10	20	40	50	25	50	10	30	30	60	30	60	20	[6] 40	40	[7] 60
Princeton loamy fine sand	30	40	30	50	10	20	30	50	25	50	—	—	30	50	20	60	50	[6] 100	40	[7] 70
Riverwash	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ross loam	80	100	70	80	60	80	70	100	100	110	70	90	60	75	50	80	60	90	20	30
Ross silty clay loam	90	110	70	90	60	80	70	90	100	110	80	100	60	75	50	80	60	90	20	30

Rugby silty clay loam	20	30	20	30	10	20	20	30	40	90	50	80	40	70	---	---	---	---	---	---
Russell loam	60	90	40	90	40	80	50	80	50	110	30	80	20	75	30	60	40	60	60	70
Russell silt loam	60	90	60	100	50	80	50	90	50	110	30	90	20	75	30	60	40	70	60	70
Russell silt loam, eroded phase.	---		10	20	---	---	10	20	25	40	---	50	---	50	---	---	---	---	---	---
Russell silt loam, shallow phase.	50	80	60	100	40	70	70	90	40	90	30	80	20	70	25	50	40	70	60	70
Russell silt loam, steep phase	---	---	20	30	10	20	10	20	40	50	---	10	---	40	---	---	---	---	---	30
Shoals silty clay loam (drained and protected by levee).	70	90	30	40	40	50	70	90	110	125	40	60	---	---	---	---	---	---	---	---
Shoals silty clay loam (undrained and unprotected by levee).	60	---	20		20		60		100	---	---			---	---	---	---	---	---	---
Stendal silt loam (drained)	50	70	40	50	30	40	50	60	75	90		---	---	---	---	---	---	---	---	---
Stendal silt loam (undrained)	30	---	20	---	10	---	40	---	60	---	---	---	---	---	---	---	---	---	---	---
Tilsit silt loam	40	80	40	70	40	60	40	60	60	90	---	60	---	---	20	50	20	50	30	40
Wellston silt loam	30	50	30	50	30	50	40	50	40	60	---	60		---	20	50	20	40	10	20
Wellston silt loam, slope phase.	---	---	---	20			---		25	40	---	20	---	---	---	---	---	---	---	10
Westland loam (drained)	90	110	80	100	80	90	90	100	110	125	70	80	60	70	50	80	70	90		---
Westland loam (undrained)	50	---	---	---	---	---	50	---	75	---	40		---	---	---		30	---	---	---
Westland silty clay loam (drained).	90	110	80	100	80	90	90	100	110	125	70	80	60	70	50	80	80	100	---	---
Westland silty clay loam (undrained).	50	---	20	---	---	---	50	---	75	---	40	---		---		---	30	---		---
Whitaker loam (drained)	60	80	70	80	50	70	60	80	75	100	50	80	20	50	20	50	30	40	---	---
Whitaker loam (undrained)	40	---	50	---	40	---	50	---	60	---	30	---		---	---	---	20	---	---	---
Whitaker silt loam (drained)	60	80	60	80	50	70	60	70	100	125	60	90	10	40	20	50	20	40	---	---
Whitaker silt loam (undrained).	50	---	50	---	40	---	50	---	75	---	50	---	---	---	---	---	---	---	---	---
Wynn silt loam	50	70	60	80	40	70	60	80	75	90	30	80	30	50	30	60	40	50	40	60
Zanesville silt loam	40	80	40	80	40	60	40	50	50	75	10	70	---	50	20	50	30	50	30	40
Zanesville-Wellston silt loams, eroded phases.	---	---	---	---	---	---		---	25	40	---	---		---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 6.—*Productivity ratings of soils in Bartholomew County, Ind.*—

Soil	Crop productivity index [1] for—																			
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100—200 bu.)		Vegetables [2]		Apples [2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Zanesville-Wellston silt loams, gullied phases.	----	-----	----	-----	----	---	----	-----	----	----	----		---	----	----	----	----	----	----	----
Zipp silty clay loam (drained)	90	100	60	80	40	60	80	100	100	125	40	80	20	60	25	50	40	60	---	----
Zipp silty clay loam (undrained).	70	-----	50	-----	20	..	60	-----	75	----	20	----	----	----	----	----	20	40	----	--

[1] The soils are given general productivity indexes and indexes that indicate the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate yield obtained on the more extensive and better soil types of regions of the United States in which the crop is most widely grown. The indexes are based upon estimates of yields, as specific yield data are very limited. The indexes in the column headed A under each crop refer to yields that may be expected under a comparatively low level of management that includes only infrequent use of legumes, manure, commercial fertilizers, or lime; the indexes in column B refer to yields that may be expected under improved practices of soil management, which include the use of manure, commercal fertilizers, lime, legumes, and green manures, and, in the case of potatoes, vegetables, and fruits, disease and insect control. Actual practices and yields in Bartholomew County vary greatly.

[2] These indexes are only locally comparative, as they do not refer to specific yield standards, although those of apples probably approximate indexes based on 100=300 bushels. In the case of vegetables they are very general, as no specific vegetables are designated.

[3] These indexes are comparative c
indexes based on 100—100 cow-acre-d
number of animal units carried per a
without injury to the pasture. For
unit per acre for 360 days of the year r
1 animal unit per 2 acres for 180 days

[4] The general productivity grade
the soils for the common crops. Ref

[5] Celery and onions are the princi
crop that is well adapted.

[6] Melons are the principal truck cr

[7] Peaches are more common than

The indexes in table 6 are estimates of yields based primarily on observations in the field and on interviews with farmers, members of the State Experiment Station and College of Agriculture staffs, and others who have had experience in the agriculture of the county and State. As such, they are presented only as estimates of the average production over a period of years. It is realized that these estimates may not apply directly to specific tracts of land for any particular year, inasmuch as the soils as shown on the map vary somewhat, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year.

The indexes in column A under each crop heading are estimates of the yields to be expected and with only the infrequent use of manure, commercial fertilizer, lime, or legumes in the rotation. The indexes in column B are estimates of yields to be expected under the more intensive types of management that include the use of commercial fertilizers, lime, manure, legumes in the rotation, and green manures. Wheat commonly receives from 100 to 200 pounds of 2–12–6 or similar fertilizer. Two to 4 tons of lime is commonly applied, depending on the specific requirements of the soil in question, for establishing legumes in the rotation.

Two sets of indexes are given to the soils with poor or imperfect natural drainage, one for the artificially drained condition and one for the natural condition. Likewise, two sets of indexes are shown for the bottom lands that are subject to periodic overflow, one for the protected condition and one for the unprotected condition.

The principal factors affecting the productivity of land are climate; soil (including its many physical, chemical, and biological characteristics); slope; drainage; and management, including the use of amendments. No one of these factors operates separately from the others, although some one may dominate. In fact, the factors listed may be grouped simply as the soil factor and the management factor, since slope, drainage, and most of the aspects of climate may be considered as characteristics of a given soil type, and because the soil type occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors, and therefore they are used where available.

General productivity grade numbers are assigned in the column "General productivity grade." As prepared for most productivity rating tables, this grade is based on a weighted average of the indexes for the various crops, the weighting depending upon the relative acreage and value of the crops. If the weighted average is between 90 and 100, the soil type is given a grade of 1; if it is between 80 and 90 a grade of 2 is given, and so on.[6] In Bartholomew County no precise mathematical procedures were followed in establishing the general productivity grade. The grade numbers were assigned arbitrarily by visual inspection of the indexes, particularly those for corn, wheat, soybeans, and mixed hay. On the soils with definite crop adaptations, such as the Genesee and Fox soils, for corn and wheat respectively, more consideration was given to the particular crop index. Since it is difficult to measure mathematically or otherwise either the exact significance of a crop in the agriculture of an area or the

[6] Grade 1+ is used for soils with a weighted average above 100.

importance or suitability of certain soils for particular crops, too much significance should not be given to the exact general productivity grade number. Information on the prevailing types of farming, the principal crops, and other land uses is given in the right-hand column of the table.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types used for each of the specified crops.

Economic considerations have played no part in determining the crop productivity indexes. The indexes cannot be interpreted, therefore, into land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained are examples of considerations other than productivity that influence the general desirability of a soil for agricultural use. In turn, steepness of slope, the presence or absence of stone, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence the ease in maintaining soil productivity at a given level. Productivity as measured by yields is influenced in some degree by all of these and other factors, such as moisture-holding capacity of the soil and its permeability to roots and water, and they are not factors to be considered entirely apart from productivity; but on the other hand, schemes of land classification to designate the relative suitability of land for agricultural use generally give some separate recognition to them.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of environment acting on the parent soil material deposited or accumulated by geologic agencies. The characteristics of a soil at any given point depend on (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and has existed since accumulation, (3) the plant and animal life in and on the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of development have acted on the material. External climate, although important in its effects on soil development, is less so than internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Bartholomew County is in the western part of the region of Gray-Brown Podzolic soils of the United States.[7] The soils were developed

[7] MARBUT, C. F. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of American Agriculture, pt. 3, 98 pp., illus. 1935.

under a mixed hardwood deciduous forest cover. They receive annual rainfall of 40 to 45 inches, and the mean annual temperature ranges from 31.6° F. in winter to 74° in summer. The soil-forming process is characterized by the leaching of soluble basic materials including carbonates of calcium and magnesium and the sesquioxides of iron and aluminum. The retention of the silica near the surface and the mechanical movement of the finer textured particles by percolating water has resulted in a lighter textured A horizon and a moderately compact and heavy B horizon. The C horizon consists of nearly unmodified parent material. Soils derived from the older geological deposits have strongly acid, columnar, compact impervious claypan horizons, designated as X, which have formed below the B horizon. A more friable, less highly leached horizon occurs between the B and C horizons of most of the upland soils and has been designated as the Y horizon.

Most of the soils of the county have been formed from drift deposits of the Wisconsin and Illinoian periods of glaciation. A belt of low dune sands borders the eastern side of the valley of the East Fork White River and its major tributaries as a result of wind deposition that occurred during and probably subsequent to the Wisconsin period. In the thinly glaciated eastern part of the county limestone of the Devonian and Silurian formations is exposed in the valleys of streams. On the western border of the county the soils are formed from sandstone, siltstone, and shales of the Borden or Knobstone formations.[8] During the Illinoian period of glaciation, ice overrode the sandstone escarpment, but only isolated remnants of glacial till remain upon it. Thus, although the county was entirely glaciated, about 6 percent of the soils have developed material residual from the underlying bedrock.

The alluvial deposits may be divided into two groups, based on their characteristics, which are due to the source of the material. Sweet alluvium is derived from Wisconsin drift and acid alluvium from mixed Illinoian drift and the Borden formation.

Table 7 is a key to the soils of Bartholomew County in which soil groups are arranged according to the character of the parent material, the color of the surface soil and the subsoil, the drainage conditions, and the topography. The soils are arranged vertically in columns according to similarities associated primarily with natural drainage, and to a more limited extent with slope and with surface soil and subsoil colors. Soil groups of similar geologic age and character of parent material are arranged horizontally. Soils in the column headed VI include shallow soils of steep slopes where surface drainage is excessively rapid. Column V includes soils with rapid internal drainage owing to the very porous character of the substrata. Soils in column IV are on moderately rolling land where surface drainage is medium to rapid and where internal drainage is thorough but not especially rapid. Soils in column III are on undulating to gently rolling land where surface drainage is moderately rapid to slow and internal drainage is somewhat slow. Soils in column II are on level to gently undulating land where surface drainage is moderately slow and internal drainage is slow. Soils

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[8] The larger part of the Wisconsin drift in Bartholomew County is leached of carbonates to depths of 3 to 5 feet, with an average of about 4 feet. The rest is leached to depths ranging from 2 to 3 feet. The two drifts have been called Early and Late Wisconsin, respectively.

TABLE 7.—*Key* [1] *to the principal*

Parent material	Soils grouped according to: VI — Pale-brown surface soil and yellowish-brown subsoil on steep slopes	V — Light-brown, brown, or reddish-brown surface soil and brown or reddish-brown subsoil on level to rolling land	IV — Grayish-brown surface soil and yellowish-brown subsoil on moderately rolling land
SOILS OF			
Wisconsin till; leached 2 to 3 feet.	----	----	Miami silt loam
Calcareous Wisconsin till; leached 4 to 6 feet.	----	----	Russell silt loam; Russell loam.
Calcareous Wisconsin till; leached 3 to 5 feet.	----	----	Russell silt loam, shallow phase; Wynn silt loam.[3]
Calcareous Illinoian till; leached 10 feet or more.	----	Parke silt loam	Cincinnati silt loam; Cincinnati silt loam, shallow phase.
Calcareous aeolian sand; uniform in texture; leached 3 to 6 feet.	----	Princeton loamy fine sand.	Princeton fine sandy loam.
Acid sandstone, siltstone, and shale.	Muskingum stony silt loam.	----	Zanesville silt loam; Wellston silt loam; Muskingum gravelly silt loam, colluvial phase.
Shallow calcareous drift and limestone.	Rugby silty clay loam.	----	Milton silt loam [4]
SOILS OF			
High-lime stratified gravel of low terraces, leached 2 to 4 feet.	----	Fox silt loam; Fox loam; Fox sandy loam; Fox gravelly loam; Nineveh loam; Nineveh gravelly loam.	----
Low lime sand, fine gravel, and silt of low terraces; leached 3 to 6 feet.	----	----	Martinsville silt loam; Martinsville loam; Martinsville fine sandy loam.
Stratified acid silt and clay of high terraces; strongly developed.	----	----	----
Stratified acid silt and clay of low terraces; less strongly developed.	----	----	Elkinsville silt loam
SOILS OF THE			
Neutral recent alluvium of first bottoms.	----	----	Genesee silty clay loam; Genesee silt loam; Genesee silt loam, high-bottom phase; Genesee loam; Genesee loam, high-bottom phase; Genesee fine sandy loam; Ross silty clay loam; Ross loam.
Acid recent alluvium of first bottoms.	----	----	Pope silt loam; Pope gravelly loam.

[1] The key presented in this table shows the same general information (with minor changes) given in the following publication: BUSHNELL, T. M. MAP OF SOIL REGIONS AND KEY TO SOIL SERIES OF INDIANA. Ind. Agr. Expt. Sta. [2] pp. La Fayette, Ind. 1933.

soils [2] of Bartholomew County, Ind.

THE UPLANDS

indicated profile characteristics

III	II	I	VII and VIII	IX and X
Brownish-gray surface soil and yellow (mottled at 20 inches) subsoil on undulating to gently rolling land	Light brownish-gray surface soil and mottled gray and yellow subsoil on level to undulating land	Light-gray surface soil and gray subsoil on level land	Moderately dark-gray surface soil and mottled gray and yellow subsoil on nearly level depressions	Dark-gray to black surface soil and gray subsoil
	Crosby silt loam		Brookston silty clay loam.	
	Fincastle silt loam; Fincastle loam.	Delmar silt loam.	Cope silty clay loam (VII).	
	Fincastle silt loam, shallow phase.			
Gibson silt loam	Avonburg silt loam	Clermont silt loam.		
	Ayrshire loam		Lyles silty clay loam; Lyles loam.[4]	
Tilsit silt loam				
THE TERRACES				
	Homer loam		Westland silty clay loam; Westland loam; Zipp silty clay loam.	Abington silty clay loam; Carlisle muck (X).
	Whitaker silt loam; Whitaker loam.			
Haubstadt silt loam.	Dubois silt loam			
Pekin silt loam	Bartle silt loam	Peoga silt loam		
BOTTOM LANDS				
Eel silty clay loam; Eel silt loam; Eel loam.			Shoals silty clay loam.	
Philo silt loam	Stendal silt loam	Atkins silt loam		

[2] Slope, steep, eroded, and gullied phases of soils not shown.
[3] Leached to underlying limestone at 3 to 5 feet.
[4] Largely in terrace positions.

in column I lie on level land where both surface and subsoil drainage are very slow under natural conditions. Soils in the column headed VII and VIII are in depressions with natural outlets higher than the level of the soils in most instances, so that under natural conditions the water must drain away very slowly underground or remain indefinitely to keep the land in a swampy condition; soils labeled VII are lighter colored than the rest in this column, and in most instances outlets from the depressions have been lowered recently so that surface drainage can take place very slowly. In the column headed IX and X, soils originally were swampy at all times, although at present many of them have been drained artificially.

The oldest geological deposits and some of the younger soils occur in the residual sandstone and shale and limestone parts of the county. The sandstone area consists of a very completely and thoroughly rolling upland in which 60 percent of the area occurs as steep slopes having shallow soils with little horizon development. The soils have not been in place long enough nor have they absorbed sufficient rain water to develop the usual regional profile. Soils developed from limestone are neutral to slightly alkaline in reaction because sufficient time has not elapsed for these soils to be thoroughly leached of bases. The time interval between the glacial periods is most strikingly shown by the depth to which carbonates of lime and magnesia have been leached. The average depth to calcareous till in the younger part of the Wisconsin, the older part of the Wisconsin, and the Illinoian glacial region is 30, 50, and 110 inches, respectively. The till in the different areas is similar in composition, and acid-neutralizing values range from 20 to 30 percent; that is, the material contains 20 to 30 percent of calcium carbonate or its equivalent. Marked differences are evident in the degree of weathering of the rocks in the till of the three periods. Extensive flat interstream areas occur in each glacial region where imperfect drainage has modified the soil-forming processes. The soils have either dense compact B horizons or impervious claypans, which impede movement of ground water.

Most of the soils of Bartholomew County are composed largely of mineral material, although some of them contain considerable organic matter. The soils have been divided into six groups based on the character of the profile as related to the degree of drainage. Three of the groups may be classed as well-drained, and the other three groups have been developed under conditions of periodic or permanent saturation. The well-drained soils are estimated to occupy 43 percent of the county.

The well-drained to excessively drained soils (columns VI, V, IV, and III of table 7) are divided into 3 groups, based on texture, structure, and consistence of the various horizons and the water-holding capacity of the subsoils and substrata. The soils of the first group (columns VI and IV) and the third (column III) have moderately loamy substrata. The second group of soils (column V) has unconsolidated substrata consisting of gravel or sand.

The first group includes the following soil series: Miami, Russell, Wynn, Cincinnati, Elkinsville, Milton, Rugby, Martinsville, Zanesville, Wellston, and Muskingum. All of these but the Rugby soils belong to the great group of Gray-Brown Podzolic soils.

Following is a description of a profile of Russell silt loam, taken

from maple-beech woods in sec. 16, T. 8 N., R. 7 E., in a rolling morainic region.

A_0. Partially decomposed leaf litter and forest mold less than one-half inch thick. The pH value is 7.3.[9]

A_1. 0 to 3 inches, a mellow dark brownish-gray silt loam containing a large quantity of well-decomposed organic matter mixed with the soil. The pH value is 6.9.

A_2. 3 to 11 inches, mellow yellowish-gray smooth silt loam having a thin platy or phylliform structure and crumbling readily into a flaky mass. The pH value is 5.4.

B_1. 11 to 18 inches, friable yellow silty clay loam having a fine-crumb structure. Sand and glacial pebbles are of more common occurrence through the rest of the profile. The pH value is 4.9.

B_2. 18 to 36 inches, somewhat compact yellowish-brown silty clay loam. The subangular nut-shaped structure particles are ⅜ to ¾ inch in diameter. The cleavage faces have a brown thin clay coating. When wet the soil mass is plastic and sticky. Below 24 inches the subsoil is more compact and is mottled with gray and rusty iron stains. The pH value is 5.3.

Y. 36 to 48 inches, slightly mottled light yellowish brown friable silty clay loam. The pH value is 5.5.

C_1. A slightly weathered calcareous heterogeneous mass of calcareous clay, silt, sand, and glacial gravel, of clay loam texture and variable color. This material was deposited during the Early Wisconsin glacial period.

The Miami soils[10] differ from the Russell soils principally in the less highly leached and thinner solum, which is developed from the younger part of the Wisconsin glacial till deposits. The B horizon is mottle free and is less highly oxidized and more compact than that of Russell soils. A friable Y horizon does not occur between the B and C horizons. Calcareous till occurs at an average depth of 28 inches. The sand and gravel fractions have not been as completely weathered in the upper horizons as in the Russell soils.

Wynn soils represent relatively shallow deposits of Early Wisconsin till on limestone bedrock. The till is usually leached to the bedrock and varies from 30 to 45 inches in thickness.

The shallow phase of Russell silt loam is intermediate in soil character between the Russell and Miami series. This soil is similar to Miami in the depth of leaching of carbonates and the absence of a friable Y horizon. The A horizon is smoother, and the B horizon is more highly oxidized, like the Russell soils. The shallow phases of the Russell and other soils of the older part of the Wisconsin glacial till are possibly products of a glacial substage intermediate between the older and the more recent Wisconsin glaciers.

The Cincinnati soils, which are derived from Illinoian glacial till, differ from the Russell soils in the color and kind of horizons and the depth and degree of leaching of basic materials. The entire profile is highly acid to the calcareous till, which occurs at an average depth of 10 feet. The B horizon is less compact than that of the Russell soils. An incipient mottled gray and yellow siltpan or X horizon occurs at an average depth of 3 feet. Cincinnati silt loam is developed on the rolling topography of a stream-dissected level till plain.

The Elkinsville soils are developed in alluvial terrace positions from moderately acid stratified silts and clays. Morphologically the

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[9] Determined by colorimetric methods.

[10] BYERS, H. G., ALEXANDER, L. T., and HOLMES, R. S. THE COMPOSITION AND CONSTITUTION OF THE COLLOIDS OF CERTAIN OF THE GREAT GROUPS OF SOILS. U. S. Dept. Agr. Tech. Bul. 484, 39 pp. 1935.

soil is similar to the Cincinnati, having A, B, Y, and C horizons with occasional evidence of an incipient X horizon or claypan. Owing to the rather recent deposition of much of the material, the soil is not so well developed structurally and texturally as is the Cincinnati.

The Milton soils of Bartholomew County are Gray-Brown Podzolic soils derived essentially from mixed limestone residuum and glacial drift of Wisconsin age on terraces. For the most part they have heavy brown silty clay lower B horizons derived from limestone and lighter textured A and upper B horizons derived chiefly from drift. Where alluvial drift is the dominant parent material the subsoil may be more friable than is typical. Sufficient time has not elapsed to remove the basic material and develop an acid soil. Limestone occurs at an average depth of 28 inches.

The Martinsville series includes Gray-Brown Podzolic soils derived from stratified sand, silt, and clay having a low carbonate content and of Wisconsin glacial origin. They have distinctly friable B horizons that are light brown to brown.

Rugby silty clay loam is a Brown Forest soil with a dark brownish-gray A horizon that occurs on steep slopes where it is developed from the relatively pure Sellersburg and Silver Creek limestones. Organic accumulation in the surface soil ranges from 8 to 12 inches, below which the subsoil is tough yellowish-brown silty clay or silty clay loam. Bedrock usually occurs within 30 inches of the surface. Parent-material lime has not been entirely removed from the soil, and the entire profile is neutral to alkaline in reaction.

The Zanesville, Wellston, and Muskingum soils have developed over the sandstone and shale of the Knobstone formation. They have been differentiated largely on morphological characteristics and the extent of soil development that is closely related with relief.

The Zanesville series includes Gray-Brown Podzolic soils on the rounded ridge tops and have A, B, weak X and Y, and C horizons. The solum is free of sandstone, siltstone, or shale fragments to a depth of 3½ feet or more. Periodic saturation of the subsoil is shown by gray mottling above the weak claypan horizon (X).

The Wellston soils occur on knife-edged ridge tops where the solum is free of shale or sandstone fragments to a depth of 2½ feet or less. The bedrock of sandstone and siltstone occurs at a depth of less than 3 feet. The development of horizons consists of A, B, and parent rock, with the B horizon usually mottle free.

The Muskingum soils occur on slopes of 30 percent or more. The soils are Lithosols consisting of A and C horizons in which sandstone rocks of all sizes occur from the surface to the bedrock. An incipient textural and structural B horizon is developed in a few places, but the typical subsurface horizon consists of yellowish, mellow, slightly gritty silt loam, overlying sandstone with some interbedded shale and siltstone at a depth of 18 inches or less.

The second group of the well-drained soils consists of soils having strong-brown B horizons ranging in texture from clay loam to clayey sand and underlain by unconsolidated calcareous sand or gravel. Included in this group are the types and phases of the Fox, Nineveh, Parke, and Princeton series.

Following is a description of a profile of Fox loam taken from a gravel pit in sec. 20, T. 10 N., R. 6 E. It occurs on a level terrace posi-

tion approximately 12 feet above the river flood plains. This soil was originally timbered with walnut, hackberry, ash, white oak, and other trees.

A_1. 0 to 4 inches, brown to pale-brown loam that crumbles into a structureless mass. It is medium acid.

A_2. 4 to 9 inches, brownish-gray loam containing slightly less organic matter than A_1. It is medium acid.

B_1. 9 to 15 inches, yellowish-brown friable clay loam, moderately plastic and sticky when wet. The structure is granular. It is medium acid.

B_2. 15 to 35 inches, strong-brown to dull reddish brown gravelly clay loam, which is plastic and sticky when wet and hard when dry. It is medium acid.

B_3. 35 to 38 inches, dark-brown gravelly clay loam, very plastic and sticky when wet and very hard when dry. It is neutral in reaction.

C. 38 inches +, yellowish-gray calcareous stratified sand and rounded gravel of glacial origin, consisting of limestone, dolomite, granite, diorite, feldspar, quartz, and other rocks.

The Nineveh soils are developed on highly calcareous stratified gravel. They differ from Fox soils chiefly in the darker color and higher organic content of the surface soil and in the neutral reaction of the surface soil and subsoil.

The Parke soils are derived from partly assorted clay, sand, and gravel of the Illinoian glacial period. The relief is flat to rolling. The main horizons are A, B, Y, and C. The B horizon consists of light reddish-brown silty clay loam, which is underlain by friable light reddish-brown gravelly or sandy clay loam or loam at a depth of 40 to 60 inches. The profile is strongly acid to a depth of 10 feet or more. Pockets of assorted gravel and sand occur in some places. Heavy till generally occurs below a depth of 10 to 15 feet, but in places it occurs at 7 or 8 feet.

The Princeton soils are derived from aeolian sands of Wisconsin glacial age, bordering the east side of the valleys of the larger streams. Horizon development consists of A, B, Y, and C. The brown to yellowish-brown B horizon varies from a moderately heavy clay loam to a loamy fine sand. A loose somewhat reddish-brown fine sand horizon overlies the yellowish-gray calcareous fine sand, which occurs at an average depth of 5 feet.

The third group of the well-drained soils includes soils not so well drained as those of the first two groups—the Gibson, Haubstadt, Tilsit, and Pekin soils. They occur on nearly flat to undulating relief and have heavy siltpan subsoils, so that drainage is less rapid, and the soils may be considered Planosols.[11] These soils have grayish brown A horizons and yellow unmottled silty clay loam B horizons to an average depth of 20 inches. Internal moisture movement is retarded by a heavy impervious claypan or X horizon occurring at an average depth of 3 feet. A more friable horizon overlies the parent material.

The Gibson soils are derived from Illinoian till. The profile is strongly acid down to the calcareous till, which occurs at an average depth of 10 feet. The soil occurs on flat areas adjoining the small streams.

[11] BALDWIN, M., KELLOGG, C. E., and THORP, J. SOIL CLASSIFICATION. U. S. Dept. Agr. Yearbook (Soils and Men) 1938: 979–1001. 1938.

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The Haubstadt soils are derived from stratified slackwater (lacustrine) silts and clays of mixed origin but consisting largely of Illinoian drift. The profile is strongly acid to a depth of 6 feet or more.

The Tilsit soils occur in association with Zanesville soils on undulating areas on the broader ridge tops of the rolling Knobstone region. They have A, B, X, Y, and C horizons and have developed over interbedded sandstone and shale, which occurs at depths of 5 feet or more. The entire profile is strongly acid.

The Pekin soils are developed from more recent deposits of acid alluvium than the Haubstadt soils, which they closely resemble. Morphologically the soils are similar. The Pekin has reached this condition probably in a shorter time owing to the acid character of the deposits. The B horizon is not quite so compact or so well developed structurally as that of Haubstadt, and the X horizon is less consistent in occurrence. Some areas are subject to occasional overflow.

The soils that have been developed under periodic or continuous excess moisture conditions comprise 35 percent of the area of the county. They have been divided into three groups based on surface color and drainage conditions. These groups are (1) imperfectly drained soils having light brownish-gray A horizons and mottled gray and yellow B horizons; (2) very slowly drained intermittently wet and dry soils having light-gray A horizons and gray subsoils; and (3) Wiesenboden or timbered Wiesenboden soils with dark-colored highly organic upper horizons and developed under permanent swamp conditions.

The imperfectly drained group includes the following soil series: Avonburg, Dubois, Bartle, Crosby, Fincastle, Homer, Zipp, and Ayrshire. The first three are Planosols and the rest are semi-Planosols.

Following is a description of a profile of Avonburg silt loam taken along a fence row near Ogilville. It occurs on flat to slightly sloping areas usually having less than 3 percent slope.

A_1. 0 to 5 inches, light brownish gray smooth silt loam that has a platy or phylliform structure and contains many small iron-manganese concretions. It crumbles under slight pressure to a structureless mass. The pH value is 5.5.

A_2. 5 to 10 inches, very light brownish-gray smooth silt loam having a platy structure and many concretions. The pH value is 5.2.

B_1. 10 to 17 inches, mottled gray and yellow light silty clay loam that has a coarse granular structure. The pH value is 4.8.

B_2. 17 to 22 inches, mottled gray and yellow silty clay loam that has a granular structure. The pH value is 4.8.

X_1. 26 to 30 inches, predominance of light-gray silt capping and mixed with gray and yellow mottled silty clay loam. The pH value is 4.8.

X_2. 30 to 46 inches, columnar mottled gray and yellow silty clay with a thin coating of light-gray silt on the cleavage faces. It is plastic and sticky when wet, very hard when dry, and impervious to moisture movement. The pH value is 4.8.

Y_1. 46 to 66 inches, more friable mottled gray and yellow slightly gritty silty clay loam, which is moderately hard when dry.

Y_2. 66 to 107 inches, dull-yellow to brownish-yellow silty clay loam containing a considerable quantity of sand and glacial pebbles such as granite, hornblende, quartz, and chert. The pH value is 7.0.

C_1. 107 to 115 inches, calcareous yellow and brownish-yellow glacial till. Siliceous rocks predominate.

The Dubois soils are derived from stratified silts and clays of Illinoian glacial material. The profile is similar in most respects to that of Avonburg except that the substratum is free of glacial gravel.

The Bartle soils are developed from acid stratified alluvial silts and clays of mixed Illinoian glacial till and sandstone and shale origin. Some of the deposits are probably of recent origin, as many areas are only slightly higher than the adjacent alluvial soils. Although the soil is similar morphologically to the Dubois, the soil is less well developed and more silty and friable throughout, and the siltpan horizon is not consistently developed.

The Crosby soils have been developed over the younger Wisconsin glacial till. The profile is moderately acid, the soil being leached of carbonates to an average depth of 28 inches. The B_1 horizon is heavy and tough and may be called a siltpan. It contains considerable quantities of partly weathered sand and glacial pebbles throughout the A, B, and C horizons. The rocks are less highly weathered than the Illinoian pebbles.

The Fincastle soils are intermediate in soil development between Crosby and Avonburg, as they have been derived over the older part of the Wisconsin glacial till. The carbonates have been leached to an average depth of 4 feet. The main horizons are A, B, Y, and C. The A and upper B horizons are smooth and free of coarse-textured material, but the lower B is a heavy, tough siltpan.

The Homer soils have been developed from stratified clay, silt, sand, and some gravel of the Wisconsin glacial period. The parent material contains from 10 to 30 percent of calcium and magnesium carbonates, and the soils are moderately acid in reaction. The main horizons consist of A, B, Y, and C. No differentiation in soils has been made, owing to variations in texture of the parent material, because the more gravelly substrata contain considerable quantities of clay and sand intermixed.

The Zipp soils are derived from stratified or assorted nonacid clay, bordering the Wisconsin-Illinoian glacial drift region. Owing to the heavy parent material, soil development is distinctly youthful. The A horizon is a slightly dark-brown silty clay 10 inches thick, which grades into a C horizon of compact mottled brown, yellow, and gray neutral silty clay.

The Ayrshire soils are derived from wind-deposited fine sands laid down during the Wisconsin period. Owing to the depressional or flat relief, they have been subject to a certain quantity of colluvial wash from the surrounding Princeton soils. The mottled B horizon ranges in texture from loam to clay loam and is rather compact. Calcareous waterlogged gray sand occurs at a depth of 5 feet or more. The stratigraphic relation of the horizons is A, B, Y, and C.

The very slowly drained light-colored soils are formed on level land where drainage is very slow, and the soils are saturated during much of the year and nearly dry the rest of the time. The A horizons are light gray, low in organic matter, and strongly acid. The subsoil is gray with rusty iron blotches, stains, and concretions scattered through it. Delmar, Clermont, and Peoga silt loams are the soils included in this group.

Delmar silt loam is derived from the older part of the Wisconsin glacial till. It occurs on small flat areas on the broad divides

or bordering the poorly drained dark-colored soils. Following is a description of a profile of Delmar silt loam as observed east of Nortonburg in a beech-maple woods.

A_0. ¼ to ½ inch, a thin covering of partly decomposed leaf litter. The pH value is 7.2.

A_1. 0 to 3 inches, slightly dark brownish-gray smooth silt loam containing a considerable quantity of well-decomposed organic matter. The pH value is 7.0.

A_2. 3 to 12 inches, light-gray smooth silt containing rusty-brown iron concretions and stains. It has a platy structure and crumbles under slight pressure into a flaky mass. The pH value is 6.7.

B_1 12. to 18 inches, gray silty clay loam containing numerous rusty-brown mottlings and concretions. It has a fine-crumb structure, breaking into angular particles one-fourth inch in diameter. The profile is nearly free of grit to the B_2 horizon. The pH value is 6.4.

B_2. 18 to 32 inches, grades into a tough, compact, brown and grayish-brown mottled silty clay having a nut structure. There is an increase in the quantity of sand and glacial pebbles through the rest of the profile. The pH value is 6.0.

Y_1. 32 to 45 inches, friable slightly mottled gray and yellowish-brown gritty silty clay loam. The pH value is 6.8.

C_1. 45 to 52 inches +, calcareous friable grayish-yellow till. The glacial pebbles consist of limestone, granite, quartzite, and hornblende. The glacial pebbles found throughout the profile are only moderately weathered.

The Clermont soils have developed from strongly acid thoroughly leached Illinoian till in which the carbonates have been removed to an average depth of 10 feet. The stratigraphic relation of the horizons is A, X, Y, and C. The A horizon to a depth of 30 inches or more consists of uniformly smooth floury light-gray silt loam with rusty iron mottlings and small iron-manganese concretions. The lower part of the A horizon consists of a heavy silt loam, but there is no definite evidence of the development of a structural or textural B horizon. A compact, tough, impervious, columnar silty clay X or siltpan horizon is developed at an average depth of 32 to 42 inches, below which the soil becomes more friable and more highly oxidized.

Peoga silt loam is similar in most respects to Clermont silt loam except that it is derived from noncalcareous stratified silts and clays washed largely from Illinoian materials but partly from sandstone, siltstone, and shale areas. Although the two soils are similar in character, the Peoga is not so well developed and is more silty throughout and occasionally lacks the siltpan X horizon.

The dark-colored, poorly drained Wiesenboden soils comprise a group that have been developed in depressions where nearly permanent swamp conditions prevailed for a long period of time. The profiles are quite different in morphology and reaction from those of the soils formed above water. Water carried the basic leachings from the associated light-colored soils to these swampy areas, where the principal vegetation consisted of marsh grasses and sedges and swamp-forest trees. The organic matter is well mixed with the mineral soil to a depth of 16 to 20 inches, below which a bluish-gray and yellow mottled glei horizon is developed. Soils included in this group belong to the Brookston, Cope, Lyles, Westland, and Abington series.

The Brookston soils are developed over Wisconsin glacial till, but the upper part has been modified by slight depositions of silt and clay washed from the surrounding soils. Brookston silty clay loam, the

predominant type, has a dark-gray highly organic surface soil 15 to 18 inches thick. It grades into a mottled gray and yellow compact silty clay, which is underlain by calcareous till at a depth of 3 to 7 feet. The entire profile is neutral to alkaline in reaction.

The Cope soils are much like the Brookston but are slightly acid in reaction and not quite so dark-colored. They are associated on the older part of the Wisconsin till with Russell, Fincastle, and Delmar soils, while the Brookston is associated with Miami and Crosby soils.

The Lyles soils occur in terrace and low upland positions associated with Princeton soils and are dark-colored like the Brookston soils. They are partially derived from wind-deposited sand and from colluvial and alluvial wash from the Princeton soils. They are neutral in reaction and friable throughout the profile, owing to the sand content.

The Westland soils are developed from stratified clays, silts, and gravels of the Wisconsin glacial period. They occupy former outwash channels on the terraces. The texture is variable, but there is generally sufficient gravel or sand present to make the soil friable. They are dark-colored in the surface layers and have gravel in the substrata.

The Abington series has been differentiated from the Westland primarily because it is naturally still more poorly drained. It occurs in deeper depressions where there has been a slightly greater accumulation of organic matter in the mineral surface soil and the subsoil has a more distinctly bluish gray color. Rusty-brown blotches, stains, and concretions are of common occurrence.

Several areas of Bog soils occur that are known as Carlisle muck. The organic matter is well decomposed, black to dark brown and free of noticeable mineral deposition. Light-gray calcareous silt or marl generally occurs at a depth of less than 3 feet.

The alluvial soils occurring on the flood plains of streams represent about 22 percent of the area of the county. They include two groups: (1) the neutral or slightly alkaline soils developed on stream deposits from the Wisconsin glacial drift, and (2) the strongly acid soils developed (locally) from alluvium of the Illinoian drift and siltstone, sandstone, and shale area. These are the youngest mineral soils in the county. No very distinct textural horizon differentiation exists. Variations between soils are due to drainage, organic-matter content, and source of the sediments as it affects the acidity and mineral composition. These soils may be subdivided on the basis of drainage as follows: (1) Well-drained weak-brown soils that are unmottled throughout the 3-foot section. The series represented in this group are the Genesee and Ross of the neutral group and the Pope of the acid group. (2) Fairly well-drained soils having pale-brown surface soils to a depth of 18 inches or more, where they become mottled gray and yellow. Eel is the only representative of the neutral group, and Philo represents the acid group. (3) Imperfectly drained soils that have light brownish-gray or medium-gray surface soils and coarsely mottled gray and yellow subsoils below a depth of 10 inches. Shoals is the representative in this group of the neutral soils and Stendal of the acid soils. (4) Poorly drained light-gray soils having gray subsoils. The Atkins series represents the acid soils in this group.

MANAGEMENT OF THE SOILS OF BARTHOLOMEW COUNTY

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The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level, in a profitable way, and then keeping it up, is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful. A knowledge of the soil is highly important. Different soils present different problems of treatment, and each soil must be studied and understood in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless in the long run it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States. A proper system of treatment is necessary to make a soil profitably productive.

PLANT NUTRIENTS

Table 8 shows the approximate total content of nitrogen, phosphorus, and potassium, and the weak-acid-soluble, or available, phosphorus and potassium in the different soils in Bartholomew County, expressed in pounds of elements per acre in the 6- to 7-inch plowed surface soil.

TABLE 8. -*Approximate quantities of nitrogen, phosphorus, and potassium in certain soils of Bartholomew County, Ind.*

[Elements in pounds per acre of surface soil, 6 to 7 inches deep]

Soil type	Total nitrogen	Total phosphorus [1]	Total potassium	Weak-acid-soluble phosphorus [2]	Weak-acid-soluble potassium [2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Miami silt loam	2,200	610	30,600	15	160
Russell silt loam	2,600	600	26,400	15	175
Russell silt loam, shallow phase	2,400	690	30,270	20	285
Russell loam	1,800	380	26,560	15	160
Wynn silt loam	2,800	750	33,120	15	320
Crosby silt loam	2,000	730	28,420	20	160
Fincastle silt loam	2,400	510	26,400	25	150
Fincastle silt loam, shallow phase	2,200	570	27,410	25	195
Fincastle loam	1,800	470	25,560	15	90
Delmar silt loam	2,400	600	28,420	15	125
Cincinnati silt loam	2,400	450	31,270	10	225
Cincinnati silt loam, shallow phase	2,000	430	31,950	5	280
Parke silt loam	2,200	450	33,460	5	145
Gibson silt loam	2,000	430	28,250	10	195
Gibson silt loam, slope phase	2,000	400	26,900	10	210
Tilsit silt loam	2,600	640	28,580	10	230
Zanesville silt loam	2,000	620	30,430	5	320
Wellston silt loam	2,000	650	31,000	25	185

[1] Soluble in strong hydrochloric acid (specific gravity 1.115).
[2] Soluble in weak nitric acid (fifth normal).

TABLE 8.—*Approximate quantities of nitrogen, phosphorus, and potassium in certain soils of Bartholomew County, Ind.*—Continued

[Elements in pounds per acre of surface soil, 6 to 7 inches deep]

Soil type	Total nitrogen	Total phosphorus	Total potassium	Weak-acid-soluble phosphorus	Weak-acid-soluble potassium
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Muskingum gravelly silt loam, colluvial phase	3,000	610	37,500	10	355
Elkinsville silt loam	2,000	430	28,250	10	310
Haubstadt silt loam	2,400	450	28,250	15	160
Pekin silt loam	2,600	700	23,000	20	150
Clermont silt loam	2,000	380	22,360	15	150
Avonburg silt loam	2,200	440	24,210	10	135
Dubois silt loam	2,200	500	24,210	10	125
Ayrshire loam	1,800	490	20,680	35	135
Princeton fine sandy loam	2,000	450	24,210	80	170
Princeton loamy fine sand	1,200	400	21,000	90	150
Brookston silty clay loam	5,000	1,190	31,610	110	410
Cope silty clay loam	4,200	1,100	32,000	100	350
Westland silty clay loam	5,800	1,220	28,080	130	285
Westland loam	5,400	1,050	24,890	120	245
Abington silty clay loam	7,000	1,490	25,560	170	210
Lyles silty clay loam	4,400	1,200	30,000	120	220
Lyles loam	4,000	810	22,870	220	195
Bartle silt loam	2,000	490	26,000	10	130
Peoga silt loam	1,800	740	20,500	40	210
Whitaker silt loam	2,400	510	26,230	25	140
Whitaker loam	2,400	620	26,000	35	185
Homer loam	2,400	820	25,400	50	185
Fox silt loam	2,600	860	29,090	45	200
Fox loam	2,000	690	24,550	25	175
Nineveh loam	2,200	600	25,560	25	150
Fox sandy loam	2,000	500	25,560	115	175
Nineveh gravelly loam	2,200	560	20,680	150	225
Martinsville silt loam	2,600	770	30,270	10	150
Martinsville loam	2,000	550	24,380	30	160
Martinsville fine sandy loam	2,000	420	27,740	50	135
Milton silt loam	2,200	770	30,430	25	260
Genesee silty clay loam	3,400	1,280	32,120	95	270
Genesee silt loam	2,800	960	25,050	80	270
Genesee silt loam, high-bottom phase	2,800	940	29,260	60	340
Genesee loam	2,200	670	28,420	80	340
Genesee loam, high-bottom phase	2,200	880	23,880	175	195
Ross silty clay loam	3,200	1,140	31,440	80	250
Eel silty clay loam	3,400	1,200	32,450	105	405
Eel silt loam	3,200	960	27,600	50	170
Eel loam	2,600	860	26,500	70	230
Shoals silty clay loam	3,400	1,350	31,270	140	380
Pope silt loam	2,600	680	29,590	10	250
Pope gravelly loam	2,400	570	34,810	10	230
Philo silt loam	2,000	560	29,760	5	270
Stendal silt loam	2,600	520	27,240	10	210
Atkins silt loam	2,600	490	25,560	20	175

The total plant-nutrient content is more indicative of the origin and age of a soil than of its fertility. This is particularly true of potassium. The quantity of total potassium in a soil is seldom indicative of its need for potash. Some Indiana soils that have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization, because so little of the potassium they contain is available.

The total content of nitrogen is generally indicative of the need for nitrogen, although some soils with a low content may have a supply of available nitrogen sufficient to grow a few large crops without the addition of that element. Soils having a low total nitrogen content soon wear out, so far as that element is concerned, unless the supply is replenished by the growing and turning under of legumes or by the use of nitrogenous fertilizer. The darker soils are generally higher

in organic matter. Organic matter and nitrogen are closely associated in the soils of Indiana, hence it is a fairly safe rule that the darker the soil the richer it is in nitrogen.

The quantity of phosphorus soluble in weak acid is considered by many authorities to be a still better indication of the phosphorus needs of a soil. The depth of a soil may modify its needs for phosphates. Everything else being equal, the more weak-acid-soluble phosphorus a soil contains the less it is likely to need phosphate fertilizers. Where the weak-acid-soluble phosphorus runs less than 100 pounds to the acre, phosphates are usually needed for high crop yields.

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so certain an indicator as is the determination for phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash more than well-aerated deep soils.

The use of strong or weak acid in the analysis of a soil has been criticized by some, yet such analyses can more often be correlated with crop production than can analyses of the total elements of the soil. For this reason acid solutions have been employed in these analyses.

It must be admitted, however, that no one method of soil analysis will definitely indicate the deficiencies of a soil. For this reason, these chemical data are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the horizons of the soil profile, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potassium in the subsoil seems to be of relatively high availability. Crop growth depends largely on the quantity of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth in soils of relatively low analysis. If the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. The better types of soils and those containing large quantities of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the more important factors in soil fertility is the degree of acidity. Soils that are very strongly acid will not produce well, even though plant nutrients are not lacking. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where lime is deficient. Table 9 shows the percentage of nitrogen and the acidity of the important soils in Bartholomew County.

TABLE 9.—*Nitrogen, acidity, and lime requirement in certain soils of Bartholomew County, Ind.*

Soil type	Depth	Nitrogen	pH [1]	Average depth to neutral material	Indicated limestone requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Miami silt loam	0–6	0.11	6.2		
	6–18	.09	6.3	24	1–2
	18–36	.05	7.6		
Russell silt loam	0–6	.13	5.3		
	6–18	.04	5.4	45	2–4
	18–36	.03	5.4		
Russell silt loam, shallow phase	0–6	.12	5.5		
	6–18	.08	5.4	30	2–4
	18–36	.05	7.3		
Russell loam	0–6	.09	5.4		
	6–18	.04	5.3	35	2–4
	18–36	.03	6.5		
Wynn silt loam	0–6	.14	5.9		
	6–18	.10	5.8	40	2–3
	18–36	.10	5.5		
Crosby silt loam	0–6	.10	6.4		
	6–18	.07	6.2	24	1–2
	18–36	.05	(2)		
Fincastle silt loam	0–6	.12	5.5		
	6–18	.07	5.3	40	2–3
	18–36	.05	6.8		
Fincastle silt loam, shallow phase	0–6	.11	5.9		
	6–18	.07	5.4	32	1–2
	18–36	.05	7.3		
Fincastle loam	0–6	.09	5.2		
	6–18	.04	5.0	35	2–3
	18–36	.02	6.5		
Delmar silt loam	0–6	.12	5.3		
	6–18	.07	5.5	42	2–3
	18–36	.04	6.2		
Cincinnati silt loam	0–6	.12	5.1		
	6–18	.06	5.0	108	2–4
	18–36	.03	5.0		
Cincinnati silt loam, shallow phase	0–6	.10	5.1		
	6–18	.05	5.0	(3)	2–4
	18–36	.04	4.9		
Parke silt loam	0–6	.11	5.3		
	6–18	.05	5.1	120	2–4
	18–36	.03	5.0		
Gibson silt loam	0–6	.10	5.1		
	6–18	.06	4.9	108	2–4
	18–36	.04	4.9		
Gibson silt loam, slope phase	0–6	.10	5.1		
	6–18	.05	5.0	108	2–4
	18–36	.03	5.2		
Tilsit silt loam	0–6	.13	5.6		
	6–18	.05	5.0	(3)	2–4
	18–36	.03	5.0		
Zanesville silt loam	0–6	.10	5.5		
	6–18	.08	5.0	(3)	2–4
	18–36	.04	5.0		
Wellston silt loam	0–6	.10	5.5		
	6–18	.04	4.9	(3)	2–4
	18–36	.04	5.2		
Muskingum gravelly silt loam, colluvial phase	0–6	.15	5.0		
	6–18	.07	5.0	(3)	2–4
	18–36	.06	5.0		
Elkinsville silt loam	0–6	.10	5.2		
	6–18	.06	5.1	65	2–4
	18–36	.05	4.9		
Haubstadt silt loam	0–6	.12	5.3		
	6–18	.06	5.1	70	2–4
	18–36	.02	5.0		
Pekin silt loam	0–6	.13	5.4		
	6–18	.07	5.2	70	2–4
	18–36	.03	5.0		
Clermont silt loam	0–6	.10	5.2		
	6–18	.05	4.8	108	2–4
	18–36	.02	4.8		
Avonburg silt loam	0–6	.11	5.3		
	6–18	.06	4.8	108	2–4
	18–36	.04	4.9		

[1] pH determined by Morgan colorimetric method.
[2] Calcareous.
[3] Acid to bedrock.

TABLE 9.—*Nitrogen, acidity, and lime requirement in certain soils of Bartholomew County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH	Average depth to neutral material	Indicated limestone requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Dubois silt loam	0-6	0.11	5.8	70	2-4
	6-18	.05	5.1		
	18-36	.04	5.0		
Ayrshire loam	0-6	.09	5.5	45	2-4
	6-18	.05	5.6		
	18-36	.03	5.7		
Princeton fine sandy loam	0-6	.10	6.7	35	0-1
	6-18	.04	6.9		
	18-36	.02	7.0		
Princeton loamy fine sand	0-6	.12	6.8	40	0
	6-18	.05	6.7		
	18-36	.03	6.9		
Brookston silty clay loam	0-6	.25	6.6	0	0
	6-18	.19	6.8		
	18-36	.07	7.2		
Cope silty clay loam	0-6	.21	6.5	10	0
	6-18	.15	6.6		
	18-36	.05	6.9		
Westland silty clay loam	0-6	.29	6.6	0	0
	6-18	.20	6.9		
	18-36	.08	7.2		
Westland loam	0-6	.27	7.0	0	0
	6-18	.18	7.4		
	18-36	.07	[2]		
Abington silty clay loam	0-6	.35	7.2	0	0
	6-18	.23	7.2		
	18-36	.09	7.4		
Lyles silty clay loam	0-6	.22	6.8	0	0
	6-18	.14	6.9		
	18-36	.07	7.3		
Lyles loam	0-6	.20	6.6	0	0
	6-18	.13	7.0		
	18-38	.07	7.1		
Bartle silt loam	0-6	.10	5.3	70	2-4
	6-18	.04	5.0		
	18-36	.02	4.6		
Whitaker silt loam	0-6	.12	6.2	55	1-2
	6-18	.06	5.5		
	18-36	.04	5.7		
Whitaker loam	0-6	.12	5.8	60	1-2
	6-18	.07	6.0		
	18-36	.05	6.1		
Homer loam	0-6	.12	5.8	50	1-2
	6-18	.07	6.0		
	18-36	.05	6.1		
Fox silt loam	0-6	.13	6.0	43	1-2
	6-18	.10	5.5		
	18-36	.06	6.0		
Fox loam	0-6	.10	5.9	40	1-2
	6-18	.08	5.8		
	18-36	.05	6.4		
Nineveh loam	0-6	.11	6.6	43	0
	6-18	.09	6.5		
	18-36	.08	6.7		
Fox sandy loam	0-6	.10	6.2	45	0
	6-18	.08	6.4		
	18-36	.06	6.2		
Nineveh gravelly loam	0-6	.11	7.1	0	0
	6-18	.08	7.1		
	18-36	.05	[2]		
Martinsville silt loam	0-6	.13	5.9	45	2-3
	6-18	.09	5.7		
	18-36	.04	5.5		
Martinsville loam	0-6	.10	5.9	55	2-3
	6-18	.08	5.1		
	18-36	.05	5.4		
Martinsville fine sandy loam	0-6	.10	6.0	55	1-2
	6-18	.07	6.0		
	18-36	.04	5.8		
Milton silt loam	0-6	.11	6.8	22	0
	6-18	.08	6.6		
	18-36	.05	[2]		
Genesee silty clay loam	0-6	.17	7.2	0	0
	6-18	.14	7.2		
	18-36	.08	7.2		

TABLE 9.—*Nitrogen, acidity, and lime requirement in certain soils of Bartholomew County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH	Average depth to neutral material	Indicated limestone requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Genesee silt loam	0-6	0.14	7.2	0	0
	6-18	.12	7.2		
	18-36	.08	7.2		
Genesee silt loam, high-bottom phase	0-6	.14	7.0	0	0
	6-18	.12	7.1		
	18-36	.07	7.2		
Genesee loam	0-6	.11	7.3	0	0
	6-18	.09	7.3		
	18-36	.07	7.2		
Genesee loam, high bottom phase	0-6	.11	6.8	0	0
	6-18	.09	6.8		
	18-36	.07	6.8		
Ross silty clay loam	0-6	.16	6.9	0	0
	6-18	.14	6.9		
	18-36	.10	7.0		
Eel silty clay loam	0-6	.17	7.1	0	0
	6-18	.16	7.2		
	18-36	.13	7.1		
Eel silt loam	0-6	.16	7.0	0	0
	6-18	.08	7.1		
	18-36	.07	7.1		
Eel loam	0-6	.13	7.0	0	0
	6-18	.07	7.1		
	18-36	.05	7.1		
Shoals silty clay loam	0-6	.17	6.8	0	0
	6-18	.14	6.9		
	18-36	.09	7.3		
Pope silt loam	0-6	.13	5.3	(3)	2-4
	6-18	.08	5.4		
	18-36	.04	5.5		
Pope gravelly loam	0-6	.12	5.3	(3)	2-4
	6-18	.08	5.5		
	18-36	.04	5.6		
Philo silt loam	0-6	.13	6.0	(3)	2-4
	6-18	.09	6.0		
	18-36	.05	6.1		
Stendal silt loam	0-6	.13	5.5	(3)	2-4
	6-18	.09	5.5		
	18-36	.05	5.5		
Atkins silt loam	0-6	.13	5.5	(3)	2-4
	6-18	.08	5.0		
	18-36	.03	5.4		

The acidity is expressed as the pH value or intensity of acidity. A soil of pH 7.0 is neutral and contains just enough lime to neutralize the acidity. For practical purposes the pH range of 6.6 to 7.3 is considered to represent neutrality. If the pH value is more than 7.0, it indicates that there is some lime in excess. Soils with a pH value ranging from 6.0 to 6.5 are slightly acid, and those ranging from pH 5.6 to 6.0 are of medium acidity. If the pH value runs below 5.6, the soil is strongly acid. As a rule, the stronger the acidity the more lime a soil needs. The acidity is reported for the surface soil (0 to 6 inches), for the subsurface soil, and for the subsoil. It is important to know the reaction not only of the surface soil but of the lower layers of the soil as well. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely the soil is to need lime. Soils having the greater clay content, given the same degree of acidity, will need a greater quantity of lime to neutralize them. The less phosphorus, calcium, and magnesium the soil contains the more likely it is to need lime. It is well to remember that sweetclover, alfalfa,

and red clover need lime more than other crops do. As it is advisable to grow these better soil-improvement legumes in the rotation, in many places it is desirable to apply lime so that sweetclover or alfalfa will grow.

In interpreting the soil survey map and soil analyses it should be borne in mind that a well-farmed, well-drained, well-fertilized, well-manured soil that is naturally low in fertility will produce larger crops than a poorly farmed soil of a type naturally higher in fertility.

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of this county, the soils are arranged in groups according to certain important characteristics which indicate that in many respects similar treatment is required. For example, several of the silt loams of the uplands and terraces that have practically the same requirements for their improvement may be conveniently discussed as a group; thus the repetition that would be necessary if each were discussed separately is avoided. Where different treatments are required they are specifically pointed out. The reader should study the group including the soils in which he is particularly interested.

IMPERFECTLY AND VERY SLOWLY DRAINED LIGHT-COLORED LOAM, SILT LOAM, AND SILTY CLAY SOILS OF THE UPLANDS AND TERRACES

The imperfectly and very slowly drained light-colored loam, silt loam, and silty clay soils of the uplands and terraces comprise the loams of the Ayrshire, Fincastle, Whitaker, and Homer series, the silt loams of the Clermont, Avonburg, Dubois, Delmar, Fincastle, Peoga, Bartle, Crosby, and Whitaker series, and Zipp silty clay loam. Together, these soils occupy 66,432 acres, or about 25.8 percent of the total area of the county.

The several soils of this group, although they differ considerably in appearance because of their origin, topography, and natural drainage, have important characteristics in common. All these soils are more or less in need of artificial drainage; all are low in organic matter, nitrogen, and phosphorus; most of them are low in available potassium; and all are medium to strongly acid and in need of liming.

DRAINAGE

The soils of this group were all developed under conditions of imperfect or very slow internal drainage. Their level to gently undulating topography, together with heavy subsoils, makes them naturally wet and more or less seriously in need of artificial drainage. The flatter areas, especially Clermont silt loam and much of the Peoga and Bartle silt loams, need surface furrow drainage as well as tile underdrainage.

Surface drainage by means of dead furrows and open ditches is more or less practical but is wasteful of fertility in surface runoff. Tile underdrainage should be installed as early as possible in any permanent improvement program. Without tile drainage these soils cannot be managed to the best advantage and no other beneficial soil treatment can produce its full effect.

With reasonable provision for drainage, these soils respond well to lime, legumes, manure, and fertilizer and can be made highly productive. This has been fully demonstrated on the soil-fertility experiment fields on Clermont, Avonburg, and Crosby silt loams conducted by the Purdue University Agricultural Experiment Station and on similar poorly drained soils in other parts of the State. The results of experiments on these fields indicate that tile lines laid 30 to 36 inches deep and not more than 3 rods apart will give satisfactory results. Where the land is flat, great care must be exercised in tiling in order to obtain an even grade and a uniform fall. Unsatisfactory results in tiling these flat lands are traceable to errors in grades, which allow silting in low spots, and to poor grades of tile, which chip and break down easily. Only the best grade of tile should be used. Grade lines should not be established by guess or by rule-of-thumb method. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The grade, or rate of fall, should be not less than 3 inches to 100 feet. The rate of fall may be increased toward the outlet, but it should never be lessened without the introduction of a silt well or settling box, as checking the current in the line may cause the tile to become choked with silt. Silt wells may be made of brick or concrete and should be at least a foot square inside. The bottom should be a foot lower than the bottom of the tile. The well should have a removable cover, in order that it may be opened once or twice a year for the purpose of dipping out the silt that has settled in the bottom. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with a layer of straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

In a special tile-drainage experiment on the Clermont silt loam of the Jennings County experiment field near North Vernon, land tiled 3 rods apart in 1920 has since averaged 15.4 bushels more corn, 1.1 bushels more soybeans, 7.4 bushels more wheat, and 130 pounds more hay to the acre than untiled land with the same lime and fertilizer treatment. The cost of tiling was paid for by the increased yields of crops during the first 8 years of the experiment, and up to the end of 1939 the returns have totaled more than twice the cost.

LIMING

All the soils of this group are medium to strongly acid and more or less in need of liming. A strongly acid soil will not respond properly to other needed treatments until it has been limed. On the Jennings County experiment field near North Vernon, which is located on Clermont silt loam, land that received 3 tons of ground limestone to the acre in 1921 and 2 tons in 1935, in addition to being well fertilized, has averaged 15.2 bushels more corn, 6.4 bushels more wheat, and 1,390 pounds more hay to the acre than land similarly fertilized but not limed. In the 19-year period to the end of 1939 the total acre value of crop increases due to liming has amounted to over $115. On unferti-

lized land similar liming has produced crop increases amounting to $77.33 over the same period. The total cost of liming is liberally estimated at $12.50. On the Scottsburg experiment field, located on Avonburg and Gibson silt loams, $10 spent for ground limestone from 1911 to 1931 returned over $48 in crop increases.

Over 80 percent of the soils of this group will not produce a satisfactory growth of clover without liming.

To determine the lime requirements, the soil should be tested for acidity. The test is simple and should not be neglected. If the farmer cannot make the test, he can have it made by the county agricultural agent or the vocational agriculture teacher, or he can send representative samples of the soil and subsoil to the Purdue University Agricultural Experiment Station at La Fayette. Ground limestone generally is the most economical form of lime to use. Comparative values should be calculated on the calcium carbonate equivalent. On the more acid soils the first application should be at least 2 tons to the acre. After that a ton to the acre every second round of the crop rotation will keep the soil sufficiently sweet for most crops otherwise adapted to these soils.

The effect of ground limestone on yields of wheat is shown in plate 4, *A*.

ORGANIC MATTER AND NITROGEN

All the soils of this group are naturally low in organic matter and nitrogen. Constant cropping without adequate returns to the land and more or less soil erosion on sloping areas are steadily reducing supplies of these plant nutrients. In many places the original supply of organic matter has become so low that the soil has lost much of its natural mellowness, and it readily becomes puddled and baked. The only practical remedy for this condition is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary to maintain the productivity of the soil. Decomposing organic matter must also supply the greater part of the nitrogen required by crops. For this reason, legumes should provide large quantities of the organic matter to be plowed under. On the strongly acid soils soybeans may be used first, because they will stand considerable soil acidity; but the land should be thoroughly limed and put into condition to grow clover and alfalfa as soon as possible. On the naturally poor soils, liberal phosphate and potash fertilization will also be necessary to produce satisfactory crops.

Clover or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized for livestock; and all produce not fed to livestock, such as cornstalks, straw, and cover crops, should be returned to the land and plowed under. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil, and then only in proportion to the quantity of top growth that is returned to the land, either directly or in the form of manure. Wherever clover seed is harvested, the threshed haulm should be returned to the land and plowed under. Cornstalks, straw, or other crop residues should not be burned. Burning destroys both organic matter and nitrogen. Modern plows equipped with Purdue trash shields will turn down and completely cover cornstalks or other heavy

growth. Cover crops should be grown wherever possible, to supply additional organic matter for plowing under. Planting soybeans, cowpeas, or sweetclover between the corn rows at the time of the last cultivation and seeding rye as a cover crop early in the fall on cornland that is to be plowed the following spring are good practices for increasing the supply of both nitrogen and organic matter. It is important to have some kind of a growing crop on the soil during the winter, in order to take up the soluble nitrogen which otherwise would be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses will occur between crop seasons through drainage. In this latitude the ground is not frozen much of the time during the winter, and frequent heavy rains cause much leaching and loss of plant nutrients, especially nitrates, if they are not taken up by crops.

CROP ROTATION

With proper liming, drainage, and fertilization, these soils will produce satisfactorily all the ordinary crops adapted to the locality. Owing to the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, and clover, or mixed clover and timothy, constitute the best short rotation for general use on these soils after liming, especially where the corn can be cut and the ground can be disked and properly prepared for the wheat. The corn, wheat, and clover rotation can readily be lengthened to 4 or 5 years by seeding timothy, or timothy and alfalfa, with the clover and allowing the stand to remain for 2 or 3 years, to be used for either hay or pasture.

The 4-year rotation of corn, soybeans, wheat, and clover, or mixed clover, alfalfa, and timothy, is well adapted to these soils. In this rotation, rye should be seeded in the cornfields as a winter cover crop and plowed under late in the spring in preparation for the soybeans. The wheat should be seeded in the soybean stubble without plowing. On the Jennings County experiment field, on Clermont silt loam, with tile drainage, lime, and fertilization, this rotation has averaged 63.2 bushels of corn, 21.6 bushels of soybeans, 20.8 bushels of wheat, and 3,305 pounds of hay to the acre over a period of 18 years. The two legumes will build up the nitrogen supply of the soil. The soybean straw, or its equivalent in manure, should be spread on the wheat during the winter. This not only will help the wheat and lessen winter injury but also will help to insure a stand of clover. Spring oats are not well adapted to the climatic conditions of this section of the State and as a rule are not a profitable crop. Hardy varieties of winter oats and winter barley are being developed and may come into use more extensively on the better drained soils.

If more corn is wanted, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover or mixed seeding may be used satisfactorily where the second corn crop at least can be given a good dressing of manure. Where enough livestock is kept to utilize all the grain and roughage in this rotation, enough manure should be produced to make a fair application for each corn crop. A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland. Even though the land has been

properly limed, clover may be uncertain on some of these soils, owing to climatic conditions; and it has proved to be a good plan to sow a mixture of seeds made up of about 3 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, 2 pounds of timothy, and 4 pounds of Korean lespedeza to the acre. Where the seeding fails to make a satisfactory stand, soybeans make a good substitute hay crop. Lespedeza may be used to advantage in pasture mixtures and on thin spots in old pastures that need improvement, especially where the pasture land is acid and liming is not feasible.

FERTILIZATION

The soils of this group are naturally low in phosphorus, and in most of them the available supplies of this element are so very low that the phosphorus required by crops should be wholly supplied in applications of manure and commercial fertilizer. The nitrogen supplies in these light-colored soils are also too low to meet satisfactorily the needs of corn, wheat, and other nonleguminous crops, and provisions for adding nitrogen should be an important part of the soil-improvement program. The total quantities of potassium in these soils are large, but the available supplies are low. In most places, therefore, the addition of some potash fertilizer would be profitable, especially where little manure is applied. Without substantial provision for supplying all three of these fertilizer elements, the productivity of these soils will remain relatively low.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical and only really practical materials for supplying the greater part of the nitrogen needed by crops, and they should be used extensively for this purpose. A system of livestock farming with plenty of legumes in the crop rotation is, therefore, best for these soils. It will pay on most farms, however, to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some nitrogen in the fertilizer at seeding time to start the crop properly, because the nitrogen in the residues of an immediately preceding legume does not become available quickly enough to be of much help to the wheat in the fall. The leguminous residue must first decay, and that does not take place to any considerable extent until the following spring.

Phosphorus is the mineral plant nutrient in which these soils are most deficient. Soil erosion aggravates this deficiency of phosphorus. The only practical way to increase the supply of phosphorus is through the application of purchased phosphatic fertilizers, and it will prove profitable in most instances to supply the entire phosphorus needs of crops in this way. In rotations of ordinary crops producing reasonably heavy yields it may be considered that 20 pounds of available phosphoric acid to the acre is required each year. It will pay well to apply larger quantities at first, so as to create a little reserve. Enough for the entire rotation may be applied at one time, or the application may be divided according to convenience. Where manure is applied, it may be counted that each ton supplies about 5 pounds of phosphoric acid; therefore a correspondingly smaller quantity will be required in the form of commercial fertilizer.

The quantity of potash that should be supplied as fertilizer depends on the general condition of the soil and the quantity of manure used. According to the analyses in table 8, most of the soils of this group are low in available potash. If the weak-acid-soluble potassium is less than 200 pounds an acre in the 6- to 7-inch surface soil, it will probably be advantageous to use some potash fertilizer. In building up a run-down soil, rather large quantities of potash fertilizer should be used, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has improved materially. There is plenty of potassium in these soils for all time if it could be made available at a faster rate. As a rule it becomes available too slowly. This is particularly true of the level gray soils of the group, and the fertilizer for these should contain more potash than that for the brown or yellow soils. The availability of the soil potash may be increased by good farm practices, including drainage, proper tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

On the Jennings County experiment field, the results on which may be considered applicable to all of the gray soils, highly profitable returns have been obtained wherever lime, legumes, manure, fertilizer, or any combination of these has been used with a 3-year rotation of corn, wheat, and clover. During the 19 years of experimentation, the land without treatment other than tile drainage, which is the same for all plots, has produced average crop yields of only 26.4 bushels of corn, 3 bushels of wheat, and 711 pounds of weedy hay to the acre. Land that received manure alone in quantities that could be made by utilizing the entire corn crop, the wheat straw, and the hay in a livestock system averaged 53.2 bushels of corn, 9 bushels of wheat, and 1,204 pounds of hay. The limed and manured land averaged 67 bushels of corn, 13.5 bushels of wheat, and 2,162 pounds of hay. Land receiving lime, manure, and fertilizer, 100 pounds of 0–12–8 for corn and 300 pounds 2–12–8 for wheat, has averaged 76.4 bushels of corn, 22 bushels of wheat, and 3,320 pounds of hay to the acre.

The effects of phosphate and potash on yields of corn are shown in plate 4, *B*.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. When the crop rotation includes wheat, a part of the manure (about 2 tons to the acre) may be applied profitably on wheatland as a top dressing during the winter. Manure so used not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other crop seeded in the wheat. The manured cornland, unless the application is very heavy, should also receive about 100 pounds of 0–14–6 or 0–12–12 to the acre in the row or hill at planting time. Without manure, corn should be given from 150 to 200 pounds to the acre of a phosphate and potash mixture at least as good as 0–12–12, applied in the row or hill. Wheatland should be given from 200 to 300 pounds to the acre of a high-analysis complete fertilizer at least as good as 2–12–6. In places where the wheat is backward in the spring, a top dressing of about 100 pounds to the acre of a good soluble nitrogen fertilizer should be

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applied soon after growth begins. Such top dressing generally will add from 5 to 7 bushels an acre to the yield. For special crops special fertilization will be needed. Specific fertilizer recommendations for different crops on different soils under different conditions can be procured from the Purdue University Agricultural Experiment Station at La Fayette.

WELL-DRAINED LIGHT-COLORED LOAM AND SILT LOAM SOILS OF THE UPLANDS AND TERRACES

The well-drained light-colored loam and silt loam soils of the uplands and terraces comprise the loams of the Russell, Fox, and Martinsville series and the silt loams of the Miami, Russell, Wynn, Cincinnati, Parke, Gibson, Tilsit, Zanesville, Wellston, Haubstadt, Elkinsville, Pekin, Muskingum, Rugby, Fox, Milton, and Martinsville series, together with their phases. Most of the Muskingum, Rugby, and Wellston soils and the slope and eroded phases of the Cincinnati, Zanesville, Russell, Miami, and Fox soils are unfit for cultivation and are classed as nonarable lands. A separate discussion of these will be found at the end of this section on soil management. These soils occupy 101,248 acres, or about 39.1 percent of the total area of the county.

The arable soils of this group, although they differ more or less in appearance because of their origin and topography, have certain characteristics in common, with respect to which their management problems are similar. They are all low in organic matter, nitrogen, and phosphorus; many are low in available potassium; and most of them are acid and in need of liming.

DRAINAGE

The more level and gently sloping areas of Tilsit silt loam on the broader ridge tops and some areas of Martinsville loam and silt loam on the terraces may be benefited by some tile underdrainage. The Fox loam and silt loam and the Milton silt loam are often droughty, owing to shallow depth to gravel, sand, or underlying rock. The rolling and hilly upland soils of this group have fair to good internal drainage, but owing to sloping topography and slow permeability much of the rain water that falls on them is carried off over the surface instead of being absorbed for the benefit of crops, and in times of heavy rains considerable damage by erosion may result.

CONTROL OF EROSION

On the rolling and hilly upland soils of this group the problem of controlling erosion is of major importance in practical systems of soil management. Even after taking out of cultivation all the rough and very sloping land, which should never be plowed, the rest of the tillable land needs especial care in order to prevent further destructive erosion. In many places the surface soil has been carried away by erosion, and further sheet erosion and gullying are constantly making conditions worse. The surface soil contains the greater part of the store of fertility and should be protected against erosion by every practical means. Gradual sheet erosion, whereby the runoff of rain water moves the surface soil down the slope a little at a time and rather

evenly, is the most insidious form of erosion and may not be noticed until the subsoil begins to appear. Many one-time fertile fields have been irreparably damaged in this way, and many others have only a little of the surface soil left, and the plow reaches into the unproductive subsoil. Plowing and other tillage operations should extend crosswise of the slopes wherever possible, in order to prevent the formation of watercourses down the slopes, which are sure to carry away much valuable surface soil and may start gullies. Contour plowing and contour strip cropping may be most practical on fields of irregular slopes, whereas terracing may be most practical on long even slopes. By rearranging fences or other field boundaries it may be possible to arrange the cropping system in such a way as to facilitate the performance of all tillage operations crosswise of the slopes. Intertilled crops should be interspersed with small-grain and sod-forming crops. Incipient gullies or draws, forming natural waterways down the slopes, should be kept permanently in grass with a good sod of sufficient width to allow the water to spread and thereby prevent soil cutting.

LIMING

For the most part the Miami and Milton soils of this group are only medium to slightly acid in reaction and not in need of much liming. The Fox and Martinsville loams and silt loams are medium acid, and liming should be included in the improvement program, especially where alfalfa or sweetclover is to be grown. The rest of the arable soils of this group are strongly acid, and liming should be a first step in the soil-improvement program. What has been said about the liming of the imperfectly and very slowly drained soils of the uplands and terraces applies equally to these soils and should receive early consideration in plans for making these soils more profitably productive.

ORGANIC MATTER AND NITROGEN

The soils of this group are similar to those of the imperfectly and very slowly drained group in their organic-matter and nitrogen content, and what has been said about the ways, means, and importance of increasing the organic matter and nitrogen content of those soils applies equally to these soils. In fact, the rolling, light-colored, upland soils are especially in need of more organic matter in order to improve their permeability to rain water and thereby lessen surface runoff and erosion damage.

CROP ROTATION

Crop rotations for these soils may be similar to those recommended for the imperfectly and very slowly drained light-colored soils. However, on account of the erosion-control problem, cropping systems on the rolling uplands should contain a larger proportion of sod crops, and winter cover crops after corn or soybeans are especially important. On some of the terrace loams and silt loams, where corn frequently suffers seriously from drought and wheat is the most important grain crop, soybeans may be more extensively used to advantage in grain-farming systems. Where sweetclover grows well in

such situations a short rotation of wheat and soybeans has possibilities, with sweetclover seeded in the wheat as an intercrop.

Alfalfa and sweetclover may be grown on most of the soils of this group if they are inoculated properly and limed sufficiently to meet the needs of these crops. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil improvement. Special literature on the cultural requirements of these crops may be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

FERTILIZATION

The general discussion of the plant-food requirements of imperfectly and very slowly drained light-colored soils holds also for the well-drained light-colored soils, except that the well-drained soils generally are not so much in need of potash fertilizers because the potash naturally in the soil becomes available more rapidly.

SANDY AND GRAVELLY SOILS OF THE UPLANDS AND TERRACES

The sandy and gravelly soils of the uplands and terraces include Princeton fine sandy loam and loamy fine sand; Fox sandy loam and gravelly loam; Nineveh loam and gravelly loam; and Martinsville fine sandy loam. These soils are all deficient in water-holding capacity, and all except the very deep-rooted crops, such as alfalfa and sweetclover, are liable to suffer from drought. These soils occupy 11,072 acres, or about 4.3 percent of the total area of the county.

LIMING

The Fox and Princeton soils are fairly well supplied with natural lime, and the Nineveh soils have an even greater supply. Martinsville fine sandy loam is somewhat acid and in need of some liming, at least for the deep-rooted legumes. From 1 to 2 tons of ground limestone to the acre is the usual recommendation.

ORGANIC MATTER AND NITROGEN

These sandy and gravelly soils, particularly Princeton loamy fine sand, are naturally low in organic matter and nitrogen, and some special provision must be made for building up and maintaining these two constituents in order to utilize these soils to the best possible advantage. As much manure as possible, as well as all unused crop materials, should be plowed under. Special green-manure crops and cover crops, such as soybeans, cowpeas, sweetclover, rye, and winter vetch, should be planted wherever possible, to produce nitrogenous organic matter for plowing under. What has been said concerning this problem in the improvement of the upland and terrace silt loam soils applies equally well here, and the practices recommended for those soils should be followed also on these sandy soils. In fact, very sandy soils need larger supplies of both organic matter and nitrogen than do heavier soils, because they use up these constituents at a faster rate. Their loose, open, and in many places excessively aerated condition favors rapid decomposition and oxidization or burning out of the soil organic matter. For this reason

more than ordinary quantities of organic materials, such as manure, crop residues, and specially grown green-manure crops and cover crops, should be plowed under. The land should never be left bare. When any considerable quantities of nonleguminous crop residues or green manures are to be plowed under, especially on land used for truck crops, it will prove advantageous in most places to broadcast a few hundred pounds to the acre of a high-nitrogen fertilizer to aid the processes of decomposition and at the same time provide additional nitrogen for the crop that is to follow.

CROP ROTATION

These sandy and gravelly soils are best adapted to winter small grains and the deep-rooted legumes. Winter small grains make most of their growth before there is a shortage of moisture, and the deep-rooted legumes can usually obtain enough moisture in the deeper subsoil to protect them from the ordinary dry periods. Corn and spring small grains on these soils nearly always suffer from drought. Early potatoes, early tomatoes, and melons do relatively well on these sandy soils, especially those of the Princeton series, if special provisions are made for maintaining the nitrogen content and the moisture-holding capacity by frequent incorporation of leguminous organic matter. A mixture of winter rye and winter vetch is practical for this purpose, serving both as a winter cover for the land and as a source of organic matter for plowing under in the spring. Where the vetch is grown for the first time the seed or soil should be inoculated with the proper nitrogen-gathering bacteria. A 5-year rotation of melons, with a rye and vetch cover crop; early potatoes, with a rye and vetch cover crop; tomatoes; and alfalfa for 2 years offers good possibilities for utilization of the sandy soils to which these crops are adapted. Success with this rotation depends largely on the success with the cover crops and the alfalfa. All crops should be fertilized. Where alfalfa responds to additions of lime it is advisable to limit liming to 300 to 400 pounds an acre of ground limestone drilled with the alfalfa seed each time this crop is sown, because heavier liming may be detrimental to the potatoes and tomatoes. The alfalfa seeding should be made immediately after the potato harvest, and the cover crop should be seeded as soon as possible after harvesting the melons.

For general farming on most of these sandy and gravelly loam soils, a rotation of corn, soybeans, wheat or other winter grain, and a hay or pasture mixture containing a high proportion of alfalfa for one or more years may be satisfactorily practiced. An early seeding of winter rye should be made in the cornfield to serve as a winter cover crop and to provide additional organic matter for plowing under, as organic matter is always needed on these soils.

Most of these sandy and gravelly loams are well adapted to alfalfa and sweetclover. Only the Martinsville fine sandy loam seems to be in need of liming for these crops, and as most of this soil is only moderately acid, 2 tons of ground limestone to the acre is usually sufficient. A good seeding mixture for either hay or pasture is 3 to 4 pounds of early timothy and 8 pounds of alfalfa. The timothy should be seeded with the wheat in the fall.

FERTILIZATION

These sandy soils are naturally deficient in nitrogen and need special provision for building up a supply of this element. The total supply of phosphorus is so low that it should not be depleted further. As a rule available potash also is low. Stable manure should be applied as liberally as possible, both for its plant-nutrient constituents and for the organic matter it supplies, to improve the water-holding capacity of the soil, as well as its productiveness. Manure, however, is seldom available in sufficient quantities; therefore commercial fertilizers high in phosphorus and potassium must be used.

Legumes in rotation or as special green-manure or cover crops should be used to supply much of the needed nitrogen that is not provided in the form of manure. Early potatoes, melons, tomatoes, and other truck crops on these soils will respond to heavy applications of high-analysis complete fertilizers. Five hundred pounds or more to the acre of 2–12–6 or 2–16–8 should be used. Where little or no manure is used a 3–12–12 may be preferable.

For winter grains, fertilization with 200 to 300 pounds of 2–12–6 or 3–12–12 at seeding time and a spring top dressing of 15 to 20 pounds an acre of nitrogen, supplied by such materials as nitrate of soda, cyanamide, or sulfate of ammonia, are recommended. For corn, row or hill applications of phosphate-potash combinations, such as 0–14–6 and 0–12–12 at 100 pounds an acre, are most practical.

Where alfalfa or sweetclover is grown, from 300 to 500 pounds to the acre of a high-grade phosphate-potash mixture should be applied at seeding time. A continuous stand of alfalfa should receive a top dressing of phosphate and potash fertilizer every 2 years.

POORLY DRAINED DARK-COLORED SOILS

The poorly drained dark-colored soils include the silty clay loams of the Brookston, Cope, Westland, Abington, and Lyles series, the loams of the Westland and Lyles series, and Carlisle muck, of which there are only a few acres. These soils occupy 21,120 acres, or about 8.3 percent of the total area of the county. These dark-colored soils have all developed under more or less wet conditions, and as a result a common natural defect is poor drainage. After being drained they are the strongest and most productive soils in the county. The natural fertility level is relatively high, and additions of fertilizer are not yet urgently needed. The chemical analyses show fair to good supplies of available phosphorus and potassium, and the nitrogen and organic-matter supplies are fairly ample. Cope silty clay loam is more nearly deficient in this respect, as indicated by its more or less grayish cast and its shallower surface soil.

DRAINAGE

All these soils are more or less in need of artificial drainage. To a large extent this has been provided, and surplus water is fairly well taken care of. In many places, however, there would be a good response to more tiling. Where this is needed, the same procedure as suggested for the light-colored silt loams of the uplands should be followed.

LIMING

The acidity tests that have been made on these poorly drained dark-colored soils indicate no need for liming.

These soils are especially well suited to corn, and this should be the major crop in most fields where one or another of them predominates. Manure and fertilizer are not so necessary as on the lighter colored soils with which these soils are associated. Wheat, however, should generally receive a good complete fertilizer, such as a 2–12–6, in order to start it properly in the fall. Corn should generally receive a phosphate-potash mixture. On farms having both light- and dark-colored soils the manure should be applied to the light-colored soils, which are more in need of the organic matter and nitrogen that it supplies.

SOILS OF THE BOTTOM LANDS

The bottom or overflow lands in Bartholomew County may be divided into two general classes—the strongly acid (sour) bottoms, and the neutral or slightly alkaline (sweet) bottoms. The sour bottoms, consisting of Stendal silt loam, Philo silt loam, Atkins silt loam, and Pope silt loam and gravelly loam, have been formed by deposits from the acid soils of the uplands and terraces and are mostly quite acid and in need of liming. The sweet bottoms, consisting of the loams, silt loams, and silty clay loams of the Eel, Genesee, Ross, and Shoals series, and Genesee fine sandy loam, receive their deposits from the lime-bearing soils of the uplands and terraces. The soils of the bottom lands occupy 57,152 acres, or about 22.4 percent of the total area of the county. They are either alkaline or only slightly acid, and few areas need liming. Natural drainage is limited by the periodic overflows and, in the heavier types, by tight subsoils. The latter should be tile underdrained wherever suitable outlets can be obtained, in order that the land may drain more quickly after floods or heavy rains.

ORGANIC MATTER AND NITROGEN

The silty clay loams of the Eel, Genesee, Ross, and Shoals series have fair supplies of organic matter and nitrogen, but the other soils of this group are in need of additional supplies of these important soil constituents. What has been said about supplying organic matter and nitrogen to the light-colored soils of the uplands and terraces applies equally well to the light-colored soils of the bottom lands. On the lighter colored and poorer areas of these soils, especially, considerable quantities of organic matter should be plowed under, either directly or in the form of manure, and legumes should be included in the rotation wherever possible and largely returned to the land in one form or another, in order to increase the nitrogen content.

Where the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, cannot be depended on, but certain shallow-rooted legumes, such as soybeans, cowpeas, and sometimes alsike clover and lespedeza, can be grown satisfactorily. These crops should be used largely for gathering nitrogen from the air, which they will do in a large measure when the soil is properly *inoculated.* Here again it must be remembered that only the top growth plowed under, either directly or in the form of manure, can

really increase the nitrogen content of the soil on which grain crops must depend. Cover crops, such as soybeans, winter vetch, and rye, should be used to the fullest possible extent in the cornfields. Corn-stalks should not be burned but should be completely plowed under whenever this is practicable.

CROP ROTATION

Where overflows cannot be prevented, the crop rotation must consist largely of annual spring-seeded crops and such grass and clover mixtures as will not be seriously injured by ordinary floods. For the most part, corn, soybeans, and in some places, where flooding is not too prolonged, wheat with a mixture of timothy and alsike clover following for a year or two, are satisfactory crops for this land. Corn should doubtless continue to predominate, but some sort of rotation is advisable to help maintain fertility. Doubtless soybeans will become more important as a rotation crop on these soils if proper inoculation is provided. Timothy and alsike mixed will do well on most of this land after the strongly acid areas have been limed, and this crop may be allowed to stand for more than 1 year. In places where the land is too acid for alsike, lespedeza may be used. For late seeding in emergencies, early varieties of soybeans and Sudan grass for either hay or seed will be found useful.

FERTILIZATION

The sweet bottom lands of this county, which are built up of sediments derived from the upland soils of the Wisconsin glaciation, are fairly well supplied with the necessary plant foods and are not much in need of fertilizer. However, where the land has been cropped for a considerable length of time, some phosphate or phosphate and potash on corn will generally pay. Where wheat is grown it should generally receive about 200 pounds of 2–12–6 to the acre. All of the acid bottom lands are low in nitrogen and phosphorus and sometimes also in available potash. It should be recognized that in most instances the floodwater sediments coming to these bottom lands from the adjoining watersheds are not so rich as they were years ago. The rich surface soil has gone from much of the upland, and the present floods carry little but eroded subsoil material of low fertility.

Nitrogen should be supplied in applications of manure and by the growth of such legumes as will not be damaged seriously by floodwater. As a rule, commercial nitrogenous fertilizers will not pay on corn but may be used to advantage in the few places where wheat can be grown and as a top dressing on timothy meadows. For cornland, superphosphate or a phosphate-potash mixture, such as 0–14–6 or 0–12–12, in areas where a deficiency of potash is evident, should be drilled in the row or placed beside the hill at the rate of 100 to 150 pounds to the acre. In places where wheat is grown, at least 200 pounds to the acre of 2–12–6 fertilizer should be used at seeding time.

NONARABLE SOILS

The more sloping, eroded, and gullied phases of the Cincinnati, Zanesville, Russell, Miami, and Fox soils and most of the Rugby, Muskingum, and Wellston soils are not suited to ordinary farming pur-

poses and should be regarded as nontillable soils and kept out of cultivation. Some of the land in this category that has been cleared may be put into permanent pasture by seeding to a mixture of bluegrass, redtop, and lespedeza, but much of it should be reforested and given protection from livestock as the most practical means of saving it from complete destruction by erosion. Where it seems feasible to establish pasture on acid-soil areas of nonarable land, the chances of success may be greatly improved by applications of about 2 tons of ground limestone and 300 to 400 pounds of superphosphate to the acre, either on top of present stands or before fresh seedings.

Thousands of acres in this county have been ruined or damaged seriously by erosion, and such damage will become progressively worse unless decisive steps are taken to prevent it. Establishing a good vegetative cover to hold the soil in place is essential. Contour furrows on hillsides and dams or other engineering devices in gullies should be employed wherever practicable, but undisturbed forest or a solid vegetative cover of some other kind should be the ultimate aim.

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SOIL MAP
BARTHOLOMEW COUNTY
INDIANA

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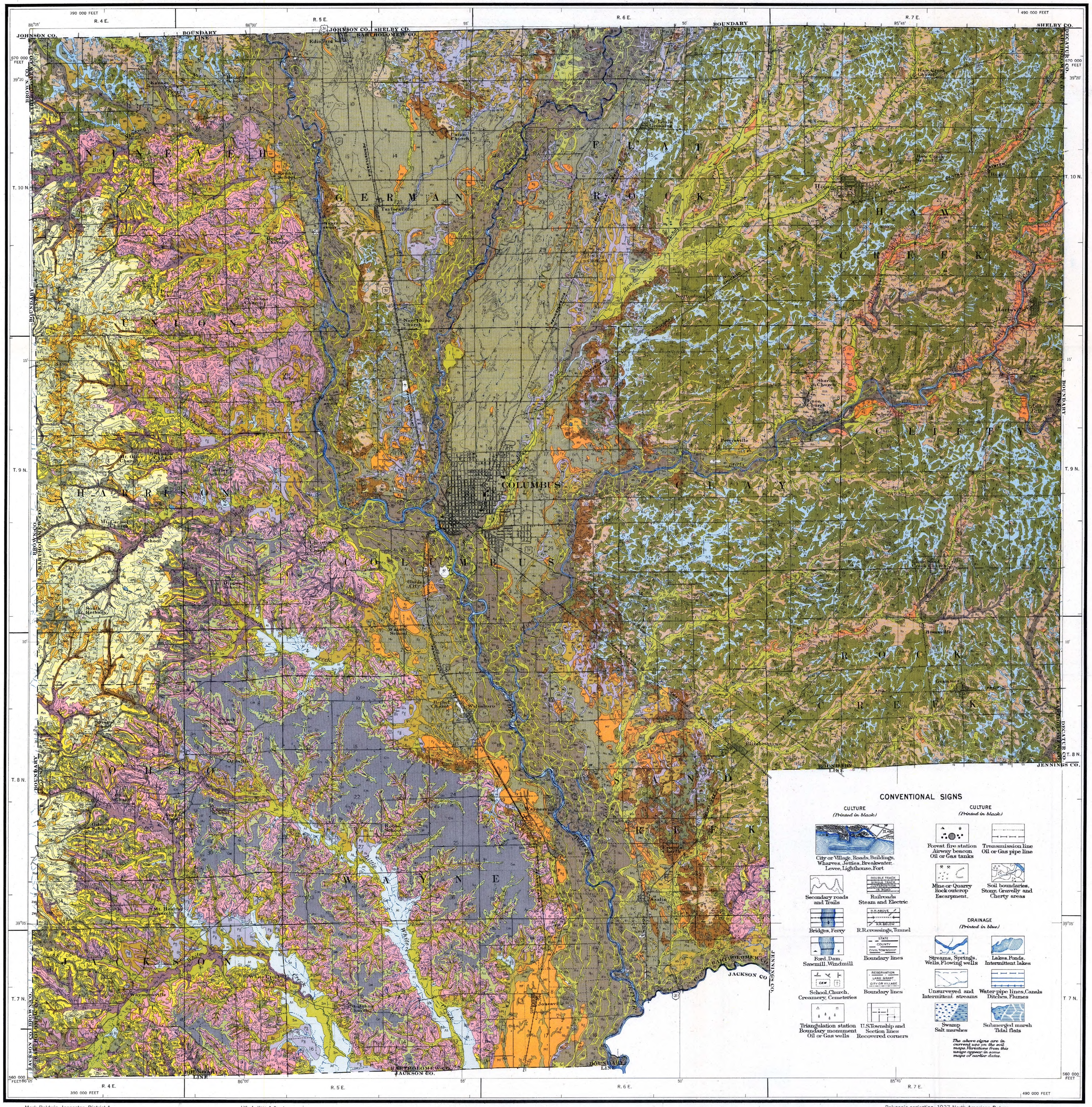

LEGEND

EXCESSIVELY DRAINED SOILS

STEEP TO VERY STEEP SLOPES SANDSTONE AND SHALE UPLANDS
- Muskingum stony silt loam — Mm

MEDIUM TO STEEP SLOPES—ILLINOIAN GLACIAL TILL PLAIN
- Cincinnati silt loam, Eroded phase — Clr
- Cincinnati silt loam, Gullied phase — Clg
- Cincinnati silt loam, Steep phase — Clz

MEDIUM SLOPES LOESSIAL MATERIALS
- Princeton loamy fine sand — Pr

MEDIUM TO STEEP SLOPES EARLY WISCONSIN GLACIAL TILL PLAIN
- Russell silt loam, Steep phase — Rsz

MODERATELY WELL-DRAINED SOILS

SMOOTH RIDGE TOPS SANDSTONE AND SHALE UPLANDS
- Tilsit silt loam — Ts

LEVEL BOTTOM LANDS
- Philo silt loam — Pl

UNDULATING TO SLOPING ILLINOIAN GLACIAL TILL PLAIN
- Gibson silt loam — Gl
- Gibson silt loam, Slope phase — Glx

GENTLY UNDULATING TO SLOPING LAKE AND STREAM TERRACES
- Haubstadt silt loam — Hs
- Haubstadt silt loam, Slope phase — Hsx
- Pekin silt loam — Pt

WELL TO EXCESSIVELY DRAINED SOILS

MEDIUM TO STEEP SLOPES—SANDSTONE AND SHALE UPLANDS
- Muskingum gravelly silt loam, Colluvial phase — Mgt
- Wellston silt loam, Slope phase — Wsx
- Zanesville-Wellston silt loams, Eroded phases — ZWr
- Zanesville-Wellston silt loams, Gullied phases — ZWg

MEDIUM TO STEEP SLOPES LOESSIAL MATERIALS
- Princeton fine sandy loam — Pf
- Princeton fine sandy loam, Slope phase — Pfx

MEDIUM TO STEEP SLOPES—EARLY AND LATE WISCONSIN GLACIAL TILL PLAINS
- Miami silt loam, Eroded phase — Mtr
- Miami silt loam, Slope phase — Mtx
- Milton silt loam — Ms
- Russell silt loam, Eroded phase — Rsr
- Rugby silty clay loam — Rc

LEVEL (OR NEARLY SO)—OUTWASH PLAINS AND STREAM TERRACES
- Fox sandy loam — Fy
- Fox gravelly loam — Fg
- Martinsville fine sandy loam — Mf
- Nineveh gravelly loam — Ng

LEVEL—BOTTOM LANDS
- Pope gravelly loam — Pm

IMPERFECTLY DRAINED SOILS

NEARLY LEVEL ILLINOIAN GLACIAL TILL PLAIN
- Avonburg silt loam — As

NEARLY LEVEL—EARLY AND LATE WISCONSIN GLACIAL TILL PLAINS
- Crosby silt loam — Cr
- Delmar silt loam — Ds
- Fincastle loam — Fl
- Fincastle silt loam — Fs
- Fincastle silt loam, Shallow phase — Fsh

NEARLY LEVEL—OUTWASH PLAINS, STREAM AND LAKE TERRACES
- Bartle silt loam — Bs
- Dubois silt loam — Du
- Homer loam — Hl
- Whitaker loam — Wl
- Whitaker silt loam — Wh
- Zipp silty clay loam — Zc

NEARLY LEVEL LOESSIAL MATERIAL
- Ayrshire loam — Al

LEVEL—BOTTOM LANDS
- Eel loam — Em
- Eel silt loam — El
- Eel silty clay loam — Ec
- Shoals silty clay loam — Sc
- Stendal silt loam — Sm

WELL-DRAINED SOILS

GENTLE TO MEDIUM SLOPES SANDSTONE AND SHALE UPLANDS
- Wellston silt loam — Ws
- Zanesville silt loam — Zs

GENTLE TO MEDIUM SLOPES—EARLY AND LATE WISCONSIN GLACIAL TILL PLAINS
- Miami silt loam — Mt
- Russell loam — Rl
- Russell silt loam — Rs
- Russell silt loam, Shallow phase — Rsh
- Wynn silt loam — Wy

GENTLE TO MEDIUM SLOPES—ILLINOIAN GLACIAL TILL PLAIN
- Cincinnati silt loam — Cl
- Cincinnati silt loam, Shallow phase — Clh
- Parke silt loam — Pk

LEVEL (OR NEARLY SO)—OUTWASH PLAINS AND STREAM TERRACES
- Elkinsville silt loam — Es
- Fox loam — Fx
- Fox silt loam — Fo
- Martinsville loam — Mo
- Martinsville silt loam — Mv
- Nineveh loam — Nl

LEVEL—BOTTOM LANDS
- Genesee fine sandy loam — Gf
- Genesee loam — Gn
- Genesee loam, High-bottom phase — Gnb
- Genesee silt loam — Gs
- Genesee silt loam, High-bottom phase — Gsb
- Genesee silty clay loam — Gc
- Pope silt loam — Ps
- Ross loam — Rm
- Ross silty clay loam — Ro

POORLY DRAINED SOILS

LEVEL ILLINOIAN GLACIAL TILL PLAIN
- Clermont silt loam — Cm

LEVEL EARLY AND LATE WISCONSIN GLACIAL TILL PLAIN
- Brookston silty clay loam — Bc
- Cope silty clay loam — Cc

LEVEL—OUTWASH PLAINS AND STREAM TERRACES
- Abington silty clay loam — Ab
- Lyles loam — Ll
- Lyles silty clay loam — Ls
- Peoga silt loam — Pg
- Westland loam — Wt
- Westland silty clay loam — Wd

LEVEL—BOTTOM LANDS
- Atkins silt loam — At
- Riverwash — Rv

ORGANIC SOILS
- Carlisle muck — Ck

MISCELLANEOUS
- Pits and quarries

Mark Baldwin, Inspector, District 1.
Soils surveyed by H. P. Ulrich, in charge, T. E. Barnes and Sutton Myers, Purdue University Agricultural Experiment Station, and O. C. Rogers, U. S. Department of Agriculture.

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1 ½ 0 1 2 3 4 Miles
Scale 1 inch-1 mile

Polyconic projection, 1937 North American Datum.
Horizontal control by U. S. C. and G. S.
Base map compiled in part from aerial photographs.
10000 foot grid based upon Indiana (East) system of plane coordinates.
Surveyed in 1935-36. Series 1936.